FINAL REPORT

Environmental Impact Assessment for the Removal of the Eel River Dam

NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES

Project No. YR101A

Jacques
Whitford

Jacques
Whitford

NBDSS PROJECT NO. YR101A

JW PROJECT NO. NBF15830

FINAL REPORT TO	**New Brunswick Department of Supply and Services** **414 Collishaw Street** **Moncton, New Brunswick** **E1C 3C7**
FOR/ON	**Environmental Impact Assessment for the Removal of the Eel River Dam**

March 31, 2006

Jacques Whitford
711 Woodstock Road
PO Box 1116
Fredericton, New Brunswick
E3B 5C2

Phone: 506-457-3200
Fax: 506-452-7652
www.jacqueswhitford.com

Jacques
Whitford

EXECUTIVE SUMMARY

BACKGROUND

This document is the Environmental Impact Assessment (EIA) Report for the Removal of the Eel River Dam Project. The Eel River dam is located in Restigouche County south of the Town of Dalhousie, approximately 600 m upstream of New Brunswick Route 134 at Eel River bar. The dam was built in 1963 by the Town of Dalhousie to provide an industrial water source (non-potable) for the area.

The history of key environmental concerns associated with the Eel River dam were outlined in a report prepared for the New Brunswick Department of the Environment (NBENV) titled *Assessment of the Impact of Removing the Eel River Dam on the Development of Environmental, Economic, and Social Benefit from the Eel River.* Historically, the Eel River estuary was the transition zone between the saltwater environment of Eel Bay and the freshwater environment of the Eel River and its tributaries. Prior to the construction of the Eel River dam (commenced in 1963), the currently impounded area formed part of the Eel River estuary. Tidal flow from Eel Bay reached the Village of Eel River Crossing. The tidal exchange was dynamic and the related sediment transport and deposition was in equilibrium as an estuarine system. The tides provided an effective flushing mechanism for the estuary.

The Eel River estuary transition zone provided a brackish water habitat for fresh and saltwater aquatic life, a habitat that is usually high in aquatic diversity. Species that have thrived in Eel River include, but are not limited to, the American eel (*Anguilla rostrata*) and the Atlantic salmon (*Salmo salar*), rainbow smelt (*Osmerus mordax*) and the migratory phase (sea-run) of the brook trout (*Salvelinus fontinalis*). The dynamic estuarine environment that existed prior to the construction of the dam provided a range of habitats for a diversity of species during portions of their life cycle. Since dam construction, which lead to the loss of several habitat types in the estuary, created a freshwater environment above the dam, and limited the ability of fish to pass through the dam, many of these species are no longer able to survive in this system.

Following construction of the dam in 1963, there was no longer any opportunity for saltwater to flow upstream past the dam and all but the lower 600 m of the estuary was lost. The natural flushing mechanism for the consequent freshwater impoundment was greatly modified. The creation of a freshwater impoundment above the dam and the modifications to water levels resulted in marked changes to the character of the river and its associated ecological community. Changes in flow (lack of tidal influences), salinity, sediment deposition patterns, water temperature, water quality, and evaporation rates caused the impoundment to be more "lake-like" than a river.

According to Eel River Bar First Nation (ERBFN), Fisheries and Oceans Canada (DFO), and the observation of others, Atlantic salmon were once plentiful in Eel River. Monitoring conducted by DFO and the New Brunswick Department of Natural Resources (NBDNR) in recent years has documented few adult salmon above the dam even though upstream spawning habitat is still suitable.

While other factors may be contributing to the decline in global Atlantic salmon populations, the results of monitoring by DFO and NBDNR in Eel River clearly demonstrate that fish passage at the location of the dam is negatively affected for all diadromous fish species known to use the Eel River and estuary for life cycle purposes.

Reports from DFO and observations by area residents, including the Eel River Bar First Nation clearly demonstrate that clam populations declined in the remaining estuary following dam construction. Clam populations that were located upstream of the dam were destroyed by the freshwater conditions. Increased sedimentation associated with the reduced tidal flushing has also been shown to occur and which contributed to substantial destruction of clam beds downstream of the dam. Finally, the presence of sewage-related bacteria, made worse by the reduced tidal exchange, has resulted in closures of the remaining clam fishery in the Eel River estuary and Eel Bay.

The rise in water level following dam construction covered the flood plain of the river, significantly altering the well-developed game bird habitat along riverbanks and surrounding the island that, prior to dam construction, was located approximately 2 km upstream of the dam. The large expanse of salt marsh that bordered the flood plain prior to 1963 supported a community of emergent vegetation (plants growing mostly above or on water, with the root growth occurring mostly underwater) that provided wildlife habitat and nutrient and contaminant removal functions. Currently only pocket wetlands and fringe wetlands remain along the shore of the impoundment. This has resulted in a loss of wetland area and a transition to less valued and lower functioning freshwater conditions.

Various investigations of natural resources within the Eel River watershed have concluded that deterioration of these resources is largely attributable to the presence of the dam. ERBFN receives financial compensation for losses of aquatic-based resources as a result of the dam, primarily related to fisheries and the harvesting of traditional plants. In December 2002, an agreement was signed with the Province of New Brunswick, Her Majesty the Queen in Right of Canada, and the ERBFN requiring that an EIA be conducted for the proposed removal of the Eel River dam that was intended to resolve fish passage and other environmental issues associated with the dam. That agreement expires in August 2006 and the expectation of the ERBFN is that the dam will be removed to restore lost estuarine conditions and provide opportunity for the re-establishment of lost aquatic resources and opportunity for the traditional uses of those resources.

The New Brunswick Department of Supply and Services (NBDSS) was designated as the proponent for the Project, and with initiating the EIA process. A harmonized provincial and federal EIA process was established with the issuance of the Final Guidelines for an Environmental Impact Assessment for the Removal of the Eel River Dam (the "Guidelines") issued on February 27, 2004. In April 2004, NBDSS contracted Jacques Whitford to undertake the EIA. Jacques Whitford led a team that comprised experts from Jacques Whitford (project managers, engineers, biologists, EIA practitioners and a public consultation facilitator) and experts (engineers, biologists, computer modellers, EIA practitioners, economists and social scientists) from other firms in New Brunswick, including AMEC Earth and Environmental Limited, ADI Limited, Gemtec Limited, and Aboriginal Resource Consultants. Collectively, this consortium was referred to as the Jacques Whitford Study Team.

NBENV appointed a Technical Review Committee (TRC) comprised of technical specialists from various provincial and federal government agencies whose jurisdictions may be affected by the Project. The agencies represented on the TRC included:

- New Brunswick Department of the Environment (NBENV);
- New Brunswick Department of Natural Resources (NBDNR);
- New Brunswick Department of Health and Wellness (NBDHW);
- New Brunswick Department of Transportation (NBDOT);
- New Brunswick Culture & Sport Secretariat – Archaeological Services Unit (NBCSS);
- Restigouche District Planning Commission;
- New Brunswick Museum;
- Indian and Northern Affairs Canada (INAC);
- Environment Canada (EC);
- Transport Canada (TC);
- Fisheries and Oceans Canada (DFO);
- Health Canada; and
- Canadian Environmental Assessment Agency.

PURPOSE OF THE EIA

The purpose of the EIA was to: evaluate the potential environmental effects, including cumulative environmental effects, of the removal of the Eel River dam; evaluate the need for mitigation; determine the significance of the residual environmental effects; and consider the need for follow-up and monitoring. Additionally, the EIA compared the residual environmental effects of the Project with the environmental effects that would result from the continued operation of the dam as is (referred to as the "Status Quo").

The EIA evaluated the Project in consideration of the following three Project Objectives:

- a long-term solution to fish passage;
- establishment of conditions that lead to the natural re-establishment of saltmarsh wetlands upstream of the current dam location; and
- improvement of habitat for softshelled clams and other shellfish upstream and downstream of the dam.

THE EIA REPORT

The EIA Report is the result of two years of research, consultation, modelling and analyses conducted by the Jacques Whitford Study Team. The Jacques Whitford Study Team prepared this EIA Report on behalf of NBDSS. The EIA Report is intended to fulfill the requirements of the Guidelines, and subsequently the reporting requirements for an Environmental Impact Assessment Report pursuant to the New Brunswick *Clean Environment Act – Environmental Impact Assessment Regulation 87-83* (*EIA*

Regulation). The EIA has also been conducted in consultation with likely federal Responsible Authorities under the *Canadian Environmental Assessment Act* (*CEAA*), and in this regard, the EIA Report is intended to support any future required *CEAA* environmental assessments.

The Final Terms of Reference (TOR) for the EIA, issued on May 20, 2005, outlined the approach that was proposed by NBDSS to meet the requirements of the Guidelines. The TOR, which was reviewed by the TRC, contained details for carrying out component investigations to provide the information necessary to support the EIA Report. The component investigations included biophysical, socio-economic and hydrodynamic modelling and geomorphological studies.

SCOPE OF THE EIA

The scope of the EIA was determined in consideration of the issues and factors identified in the Guidelines, the TOR, raised during consultation and communication, and inherent to the EIA methodology. Consultation and communication with the public, stakeholders and regulatory authorities and meetings with the Aboriginal Community were a major component of the scoping process and were ongoing for the duration of the EIA. Thirteen Valued Environmental Components (VECs) were selected for the EIA, comprising a range of biophysical and socio-economic aspects of the environment that may be affected by the Status Quo or Project. These are:

- Atmospheric Environment;
- Fish Habitat and Fish;
- Terrestrial Environment;
- Migratory Birds;
- Species at Risk;
- Water Resources;
- Vessel Navigation;
- Transportation Network;
- Current Use of land and Resources for Traditional Purposes by Aboriginal Persons;
- Tourism and Recreation;
- Labour and Economy;
- Archaeological and Heritage Resources; and
- Public Health and Safety.

EXISTING CONDITIONS

Since the construction of the Eel River dam in 1963, a freshwater habitat is present upstream of the dam and in the impoundment, with occasional intrusion of salt water overtopping the gates of the control structure during extreme tide and surge conditions. Downstream of the dam, an estuarine environment is present during primarily high river flow conditions in spring and high precipitation events. Outside this period, and during low river flow and dryer periods, a marine environment dominates and which is sharply divided from the freshwater environment by the dam, with no transitional estuarine environment between these two extreme environments to enable aquatic organisms to acclimatize. As a result of the Eel River dam, the environment and habitats have therefore been modified from pre-dam conditions. Freshwater wetlands, and associated fauna and waterfowl, now exist upstream of the dam when they were once valued salt marshes before the dam was built. The dam and the current fishway in the control structure is limiting fish passage opportunities for all diadromous fish to gain access to upstream habitats in Eel River for completing their life cycle. Downstream of the dam, the tidal prism and flushing capacity of the estuary is reduced and now contains more coarse sediment that is less suitable as clam habitat compared to pre-dam conditions. The existing condition is such that there are less available resources for traditional purposes by Aboriginal people than existed prior to the construction of the dam. Similarly, tourism and recreation activities that were present before the dam, such as clam harvesting, smelt fishing, swimming and navigation of small motorized vessels in the estuary, are not available under existing conditions. The previous industrial users of the non-potable water from the impoundment of the dam is now reduced to only NB Power, which is currently experiencing problems with the quality of the water from the impoundment and having to implement remediation measures.

PROJECT DESCRIPTION

The Project Description was developed to include the mitigation to minimize or prevent negative environmental effects from occurring. Design Criteria for the Project were developed in addition to the main project objective of safe and unimpeded passage of fish so that the Project could meet the other Project Objectives (*i.e.*, re-establishment of saltmarsh wetlands and improvement of softshelled clams and other shellfish habitats) as well. These criteria included:

- the minimum width of an opening in the Eel River dam will be sufficient to allow tidal exchange to occur in a manner that is not substantially different (similar tidal prism, range and exchange) from the pre-dam condition – this opening should be located at the north end of the dam to reflect the pre-dam channel location;
- the Project should not result in a non-permitted prohibition of the *Species at Risk Act* (*SARA*) or a violation of the *New Brunswick Endangered Species Act*;
- the Project should allow for the free passage of ice so that there is no potential for ice-jamming;
- sedimentation of the Eel River estuary as has occurred because of the dam construction should be arrested;
- there should be no further constriction of the tidal inlet channel at the mouth of the estuary and in the vicinity of the bridge on Route 134;
- the Aboriginal Heritage Gardens should be protected; and
- during the implementation of the Project, sediment generated during the Decommissioning activities must be controlled.

The Project will employ strategies to mitigate potential negative environmental effects to ecological and socio-economic features that have adapted or developed since the dam was constructed. These strategies include erosion and scour protection along critical riverbank locations. An adaptive management approach to dam removal will be implemented to ensure that significant negative environmental effects are avoided, should the Project proceed, subject to the outcome of the EIA.

The following precautionary three-staged implementation strategy was developed for the Project:

- Stage 1 – design, permitting, planning, and communication;
- Stage 2 – create an opening in the north portion of Eel River dam; and
- Stage 3 – remove the remainder of the Eel River dam.

Stage 1 includes activities relating to design, acquisition of permits and communication that must be carried out prior to creating the opening in the dam.

A 150 m-wide opening will be created in the north end of the dam as part of Stage 2 to establish hydrodynamics conditions that are similar to the pre-dam Eel River system. The excavation work would proceed from the north end of the dam towards the south, with the heavy equipment laydown area located on the south end of the dam. Erosion protection will be placed on the north bank of Eel River within defined limits to protect the shoreline from the channel that will be created at the location of the dam opening. A temporary rockfill barrier will also be constructed as a turbidity/sediment control barrier, and removed later at the end of Stage 2.

The remainder of the dam will be removed during Stage 3 by excavating in a southerly direction from the initial 150 m opening. The existing control structure and gates of the dam will be removed and the original shoreline re-established.

The above precautionary approach would ensure that the Project would be implemented successfully and that predictions made in the EIA Report would be verified through monitoring of the evolution of the channel before irreversible decisions could be made for the next planned stage.

ENVIRONMENTAL EFFECTS ASSESSMENT

A comprehensive environmental effects assessment of the Project was conducted for each of the 13 VECs. An environmental effects assessment of the Status Quo was also conducted for comparative purposes. Consideration of mitigation was included in the environmental effects assessment of the Project for each VEC. Mitigation of the Status Quo was not described, as it was included for comparative purposes only. Table 1 summarizes the results of the environmental effects assessment. A summary of the key issues that were evaluated follows the table.

Table 1 Summary and Comparison of Key Environmental Effects of the Status Quo and Project

VEC	Key Potential Environmental Effects Resulting from the Status Quo		Key Potential Environmental Effects Resulting from the Project	
	Negative	**Positive**	**Negative**	**Positive**
Atmospheric Environment	None predicted.	None predicted.	Emissions and noise generated by earth moving equipment and trucks during Decommissioning (NS).	None predicted.
Fish Habitat and Fish	Will continue to result in significant environmental effects on Fish Habitat by maintaining the obstruction to fish passage, the low quality habitat of the impoundment, and the poor water quality. Will continue to result in significant environmental effects on Fish by preventing the re-establishment of native diadromous fish populations.	None predicted.	Loss of freshwater fish species in area of impoundment (NS).	Fish passage will be restored. Water quality will be improved. Saltwater estuary will be restored.
Terrestrial Environment	Will continue to result in significant environmental effects on wetlands.	Will maintain beaver and muskrat habitat in the impoundment.	Loss of freshwater beaver and muskrat habitat in the area of the impoundment (NS).	Restoration of saltwater marsh vegetation and wildlife.
Migratory Birds	None predicted.	None predicted.	Loss of low quality freshwater habitat (NS).	Net gain of locally uncommon saltwater marsh habitat.
Species at Risk	None predicted.	None predicted.	Loss of low quality freshwater habitat (NS).	None predicted.
Water Resources	None predicted.	None predicted.	None predicted.	None predicted.
Vessel Navigation	Will continue to result in significant negative environmental effects by maintaining the existing navigation obstruction (the dam and control structure), and the poor access to the Eel River estuary from Eel Bay.	None predicted.	Loss of small vessel navigation opportunity in area of impoundment during low tide (NS).	Restored contiguous navigation from Village of Eel River Crossing to Eel River bar. Improved access from Eel Bay to the Eel River estuary. Reduced aquatic vegetation in the former area of the impoundment.

Table 1 Summary and Comparison of Key Environmental Effects of the Status Quo and Project

VEC	Key Potential Environmental Effects Resulting from the Status Quo		Key Potential Environmental Effects Resulting from the Project	
	Negative	Positive	Negative	Positive
Transportation Network	None predicted.	None predicted.	Increased traffic levels during Decommissioning (NS). Increased tourism-related traffic after Decommissioning (NS).	None predicted.
Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons	Will continue to result in significant negative environmental effects on the opportunity for Aboriginal Persons to engage in the traditional harvesting of fish and plants.	Will maintain the opportunity to trap beaver and muskrat in the impoundment.	Loss of freshwater habitat for muskrat and beaver (NS).	Restoration of traditional fish and clam populations. Restoration of traditional plant communities.
Tourism and Recreation	None predicted.	None predicted.	Loss of the unofficial trail over the Eel River dam (NS).	Increased recreation opportunity. Increased tourism potential.
Labour and Economy	None predicted.	None predicted.	None predicted.	Short-term labour need during Decommissioning. Improved economy and creation of jobs from long-term increase in tourism.
Heritage and Archaeological Resources	None predicted.	None predicted.	Accidental disturbance to archaeological resources could be significant, but is considered unlikely.	None predicted.
Public Health and Safety	The significant negative environmental effects on water quality (bacterial) in the upper portion of the impoundment will remain. The softshell clam fishery will remain closed due to potential bacterial contamination.	The dam and control structure will continue to provide limited protection against extreme high tides and storm surge up to an elevation of 3.4 m.	The risk of flooding to land along the former area of the impoundment, below an elevation of 3.4 m, will be increased slightly (NS).	The bacterial levels in the impoundment will be improved to acceptable levels. The softshell clam fishery may be re-opened pending review by Environment Canada.

NS = Not Significant

In general, the Status Quo would continue the mostly significant negative environmental effects that were observed during the time that the dam has been in place (*i.e.*, 1963-Present). Many of these issues are described in the "Background" section at the beginning of this Executive Summary. Most notably, the Status Quo would continue to prevent the successful passage of diadromous fish species, necessary to complete their life-cycle purposes. These fish populations would continue to decline, and possibly become extirpated. In addition, the Status Quo would continue to prevent the occurrence of softshelled clams upstream of the dam, and would continue to degrade the softshell habitat downstream of the dam. As a result, the Status Quo would continue to have a significant environmental effect on the ability of Aboriginal Persons to use the water and land surrounding the Eel River impoundment and estuary for traditional purposes. The only identified potentially positive environmental effect of the Status Quo is the continued provision of a freshwater water supply for the NB Power Thermal Generating Plant in Belledune. However, there were a number of issues identified with the continued use of this water supply, including legal, infrastructure-related, and water quality issues, that ultimately will prevent the continued use of this water supply regardless of the Project.

Overall, the Project will reverse, or correct, many of the mostly significant negative environmental effects on the biophysical environment that were observed during the time that the dam has been in place. Most importantly, the Project would achieve the Project Objectives described previously. Specifically, the Project would result in: a long-term solution to fish passage; conditions that lead to the natural re-establishment of saltmarsh wetlands upstream of the current dam location; and improvement of habitat for softshelled clams and other shellfish upstream and downstream of the dam. The opportunity for diadromous fish species to re-populate the Eel River estuary will be provided. It is anticipated that many of the fish populations that have experienced decline since the construction of the dam, such as the Atlantic salmon and the rainbow smelt, will be restored to levels approaching the pre-dam conditions.

The primary negative environmental effects of the Project on the biophysical environment are on those aspects of the environment that are dependent upon the freshwater environment of the impoundment. Most notably, the freshwater fish species and freshwater wetland plant and wildlife species will lose their freshwater habitat. In the case of the freshwater fish, some will be able to move up into the freshwater portion of the river, while others will no longer be able to exist in the natural, restored system. The freshwater wetlands will be lost. Some of the freshwater wildlife will be able to relocate to the freshwater portion of the river, some will relocate (*e.g.*, birds), and some will no longer be able to exist in the natural, restored system. However, these negative environmental effects are considered to be more than compensated for by the overall greatly improved natural estuarine conditions that will be restored.

The Project will also result in many positive environmental effects on the socio-economic environment. There is currently very little recreational activity or opportunity in the Eel River impoundment and estuary. Removing the dam will restore the tidal flow and the natural wetland environment. This will provide improved opportunity for navigation of small motor boats, canoes and kayaks, as well as improved natural recreational opportunities such as bird watching. The restored natural conditions will also benefit the Aboriginal Heritage Gardens, where traditional uses of the natural lands and resources in the area will be featured.

The primary negative environmental effects of the Project on the socio-economic environment are related to temporary disruptions to the road transportation network from increased traffic during the removal of the dam, and temporary elevated noise and dust, also generated by activities surrounding removal of the dam. In addition, there could be some temporary degradation to water quality from sediment generated by removal of the dam, and released from the area of the impoundment once tidal flow is restored. However, due to the temporary nature of these effects, and the recommended mitigation, the environmental effects are considered to be not significant.

EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The assessment of the effects of the environment on the Project was accomplished by identifying and describing the aspects of the environment (*e.g.*, erosion) that could have an effect on the Status Quo or Project; describing the nature of the effects (*e.g.*, accumulation of sediment around the dam); and providing a description of the mitigation (*e.g.*, erosion control measures, such as rip-rap) to minimize the risk from the identified effects of the environment on the Project. The aspects of the environment that may cause a change in the Status Quo or Project considered in the EIA Report were:

- sediment transport process (erosion and deposition);
- tidal prism (energy and extent);
- weather (precipitation, temperature and wind);
- flooding;
- ice;
- climate change (including sea level rise); and
- earthquake activity.

Engineering planning and design always involves consideration of the effects of the environment on a project, and the planning and engineering design for this Project are no exception. However, the Project is an environmental restoration effort, and does not involve permanent infrastructure. In this regard, the Project is not particularly sensitive to effects from the environment. In contrast, the Status Quo does include the dam and control structure infrastructure, and is sensitive to effects from the environment.

The sediment transport process, tidal prism, flooding and weather have the potential to affect Stage 2 of the Project. However, the rock wall barrier will minimize and control flow velocities to prevent excessive scour and provide a safe working environment during Decommissioning. All effects of the environment on the Project will be limited to the Decommissioning period and are therefore temporary.

By contrast, the effects of the environment on the Status Quo will likely persist in the form of sediment plugs, ice jams, and potential need for retrofitting as a result of climate change and sea level rise.

CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT

The cumulative environmental effects assessment expanded on the environmental effects analysis of the Status Quo and Project. Once the environmental effects of the Status Quo and Project were quantified, it was established whether the environmental effects of the Status Quo or Project overlap with those of other past, present, or future actions for each VEC. Finally, the significance of the cumulative environmental effects that result from the overlap was determined.

The environmental effects assessment of the Status Quo and Project, including the effects of the environment on the Status Quo and Project, thoroughly established the cumulative environmental effects of past and present actions, including the contribution of the dam to date. Given that the Project is an environmental restoration project, most of the resulting environmental effects of the Project were overwhelmingly positive. In this regard, the decision was made to place more emphasis of the cumulative environmental effects assessment on the negative environmental effects predicted to result from the Project, although positive cumulative environmental effects were considered and noted where appropriate. The positive and negative cumulative environmental effects of the Status Quo were assessed for comparative purposes.

The future actions identified that could overlap with the environmental effects of the Project are:

- Aboriginal Heritage Gardens;
- Restigouche Naturalist Club Waterfront Habitat Restoration;
- Village of Charlo Tourism Development;
- Village of Balmoral Sewage Aeration System;
- Village of Atholville Water Supply Evaluation; and
- Commercial Fishing.

In general, the environmental effects of the Status Quo on the biophysical environment will be negative and significant, and will largely negate the positive environmental effects of the other identified actions, such as improved water quality as a result of the Village of Balmoral Sewage Aeration System. The Status Quo will cumulatively act to make worse the environmental effects of commercial fishing on diadromous fish that use Eel River.

The Project will have positive environmental effects on the biophysical environment that will overlap with those of other actions to further increase the magnitude of the combined positive environmental effects. For example, the removal of the dam will have positive environmental effects on the water quality in the Eel River estuary that will be further improved by the Village of Balmoral Sewage Aeration System.

The overall environmental effects of the Status Quo on the socio-economic environment were determined to be negative (but not significant). In many cases, there was no identified environmental effect. In general, the Status Quo will not act cumulatively with the other actions on the socio-economic environment. Consequently, the Status Quo will not help to further the promotion of tourism and recreation in the region.

The Project will have positive environmental effects on the socio-economic environment that will positively overlap the environmental effects of the other actions. Most notably, the Project will overlap with the Aboriginal Heritage Gardens and the Village of Charlo Tourism Development to further the promotion of tourism and recreation in the region, which will subsequently improve the labour and economy in the region as well.

FOLLOW-UP PROGRAM

As part of the Environmental Management Plan for the Project, a proposed Follow-up Program will be prepared for each phase of the Project (*i.e.,* Decommissioning and post-Decommissioning) and designed to meet the requirements of both the EIA Guidelines and *CEAA*. The Follow-up Program will consist of a detailed terms of reference including objectives, content, implementation and reporting schedules. It will be filed with NBENV and provided to the public, stakeholders, and the ERBFN for review, prior to the commencement of Decommissioning activities. Feedback from these groups will be considered in finalizing the Follow-up Program.

Specific follow-up and monitoring activities were identified in the EIA Report for each of the following VECs, as determined to be appropriate based on the nature of the environmental effect, the level of certainty of the significance determination, and the importance of verifying that the prediction was accurate.

Fish Habitat and Fish VEC

Routine monitoring of suspended sediments will be conducted as necessary during Decommissioning. After Decommissioning, sediment quality and clam population densities will be monitored upstream and downstream of the current dam location at 2, 5 and 10 years following Decommissioning.

Terrestrial Environment VEC

Follow-up will focus on verifying the re-establishment of saltwater marsh upstream of the current location of the dam.

Migratory Birds VEC

Spring and fall monitoring, for two years after Decommissioning, will be conducted to verify that the transition to estuarine habitat results in a shift in bird species using the estuary.

Heritage and Archaeological Resources VEC

Additional surveying is required prior to Decommissioning along the shoreline of Blueberry Point where shoreline protection mitigation, such as rip-rap, may be used; and prior to the development of a staging area, if a staging area is required. After Decommissioning, all exposed shoreline areas that are presently covered in water by the impoundment, will undergo a comprehensive archaeological survey.

Public Health and Safety VEC

A pre-Decommissioning geodetic survey program of the elevations of nearby structures will be carried out to confirm predictions regarding flooding. Also, a post-Decommissioning monitoring program will be carried out for fecal coliforms in the estuary to verify the predicted positive environmental effects of the Project on these human sewage and waterfowl-related bacteria levels in the Eel River water.

Follow-up and monitoring activities will be carried out by qualified personnel and using standard protocols, as appropriate. There may be opportunities for capacity building and employment within the ERBFN community through involving members of the community in the recommended follow-up and monitoring activities.

OVERALL CONCLUSION

The Status Quo does not meet the Project Objectives, whereas the Project does. The Status Quo will result in significant environmental effects on the following components: Fish Habitat and Fish; Wetlands; Vessel Navigation; Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons; Heritage and Archeological Resources (not likely); and Public Health and Safety (Bacteriological Environment and Food Resource Contamination).

The Project will result in significant environmental effects that may be positive on the following components: Wetlands; Vegetation; Migratory Birds; Vessel Navigation; Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons; Tourism and Recreation; Labour and Economy; and Bacteriological Environment.

Finally, the Project will result in positive environmental effects on Fish Habitat and Fish. The Project will rectify the fish passage issue, and thus the fish passage Project Objective will be achieved. All of the current water quality concerns and sediment quality issues will be rectified. Softshelled clam stocks will have the opportunity to replenish and the Project Objective of improving habitat for clams and other shellfish will be met.

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

CONCORDANCE TABLE

Guideline Section	Section Title	Location Addressed in EIA Report (Section)
1.0	INTRODUCTION	1.0
1.1	Background	1.1.1, 1.1.2
1.2	Purpose	1.1.3, 1.2.4
1.3	Environmental Impact Assessment (EIA) Process	1.2
2.0	METHODOLOGICAL APPROACH TO EIA	2.0
2.1	General	2.1
2.2	Study Boundaries	2.1.7.1, 2.2.3
2.3	Prediction of Environmental Effects	2.1.7.3
2.4	Cumulative Environmental Effects	2.1.7.6
2.5	Mitigation, Contingency and Compensation	2.1.7.3, 2.1.7.4, 7.0, 10.0
2.6	Commitment to Monitoring and Follow-Up	2.1.7.7, 7.0, 10.0
2.7	Public, Aboriginal and Other Stakeholder Consultation	2.2
2.8	Terms of Reference (TOR)	1.1.3, 2.1, 2.2.1.1, 2.2.2.2
3.0	CONDUCT OF THE STUDY AND CONTENT OF REPORT	3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0
3.1	Project Purpose, Scope and Detailed Description	1.1.3, 1.2.4, 2.2.2, 5.0
3.2	Identification and Analysis of Alternatives	4.0, 5.1.4
3.3	Description of the Existing Environment (Biophysical and Socio-economic)	3.0, 6.0
3.4	Cross-referenced Index	This table
4.0	POTENTIAL IMPACTS	7.0
4.1	Impacts (Effects) on the Marine Environment	7.2, 7.13
4.2	Effects on the Estuarine Environment	7.2, 7.13
4.3	Effects on the Freshwater Environment	7.2, 7.13
4.4	Effects on Species at Risk (Flora & Fauna)	7.5
4.5	Effects on Terrestrial and Wetland Environments	7.3
4.6	Effects on Migratory Birds	7.4
4.7	Effects on Air Quality and Climate	7.1
4.8	Effects on Groundwater Resources	7.6
4.9	Effects on Vessel Traffic/Navigation	7.7
4.10	Effects on Traffic Patterns/Road Infrastructure	7.8
4.11	Effects on Infrastructure	7.6, 7.8
4.12	Effects on Aboriginal Land and Resource Use	7.9
4.13	Effects on Surface Water Supply	7.6
4.14	Other Social & Economic Effects	7.10
4.15	Effects of the Existing Environment on the Project	8.0

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

GLOSSARY

Agency, the	The Canadian Environmental Assessment Agency.
Albedo	The ability of a surface to reflect light.
Alternative means	The various ways that are technically and economically feasible, that the Project can be implemented or carried out (alternatives that are functionally the same). This could include, for example, alternative locations, different structural designs, and methods of development, implementation and mitigation.
Anadromous	Fish that enter freshwater to breed, but feed and grow mostly in saltwater (*e.g.*, salmon).
Anaerobic Environment	Life processes that occur in an environment in the absence of oxygen.
Anguilliform	Eel-shaped.
Anomalous	Deviating from the normal or common order, form, or rule.
Anthropogenic	Resulting from the influence of humans on nature.
Avifauna	Birds.
Biodegradable	Capable of being decomposed by biological organisms.
Biodiversity	The number and variety of organisms found within a specified geographic region.
Carbon Sequestration	A natural environment that absorbs and stores more carbon dioxide from the atmosphere than it releases, which offsets greenhouse gas emission
Carnivore	An organism that eats animals.
Catadromous	Fish that enter saltwater to breed but feed and grow mostly in freshwater. In this study, this only applies to the American eel.

GLOSSARY CONTINUED

Climatology	The study of climate.
Coagulation	To cause transformation from a liquid into a soft, semisolid, or solid mass.
Constriction	A narrowing that reduces the flow through a channel
Consultant	An individual or company hired to provide professional services to the Proponent of the EIA study, the New Brunswick Department of Supply of Services.
Deforestation	To cut down and clear away the trees or forests.
Depuration	To cleanse or purify with water.
Diadromous	Fish that migrate between freshwater and saltwater.
Dilution	The process of making weaker or less concentrated.
Diurnal	Relating to or occurring in a 24-hour period; daily.
e.g.,	For example.
Ebb (tide)	A falling tide. The transition from high tide to low tide.
Ecosystem Issues	Those ecosystem functions that have been affected over time since construction and operation of the Eel River dam, including tidal exchange, sediment transport and other physical processes, and biophysical functions (*e.g.*, wetland and other habitats, populations of flora and fauna, fish habitat, fisheries including shellfish harvesting, etc).
Eddies	Circular movements of water.

GLOSSARY CONTINUED

Environment	Under *CEAA*, means the components of the earth and includes: (a) air, water and land, including all layers of the atmosphere, (b) all organic and inorganic matter and living organisms, (c) the interacting natural systems that include components referred to in paragraphs (a) and (b). Under the New Brunswick *Clean Environment Act*, "environment" is defined as: (a) air, water, or soil; (b) plant and animal life including human life; and (c) the social, economic, cultural and aesthetic conditions that influence the life of humans or a community as they are related to the matters described in (a) and (b).
Environmental Effect	Under *CEAA*: means, in respect to a Project, (a) any change that the Project may cause in the environment (*i.e.*, both positive and negative changes), including any change to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*, (b) any effect of any change referred to in paragraph (a) on (i) health and socio-economic conditions, (ii) physical and cultural heritage, (iii) the current use of lands and resources for traditional purposes by aboriginal persons, or (iv) on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, or (c) any change to the project that may be caused by the environment, whether any such change occurs within or outside Canada.
Equilibrium	A state of balance between opposing forces or actions.
Estuarine Environment	The aquatic environment where a river meets the sea. See Estuary below.
Estuary	That part of a river or stream or other body of water having unimpaired connection with the open sea, where the sea water is measurably diluted with freshwater derived from land drainage.
Eutrophic	A body of water that has become enriched in dissolved nutrients, evidenced visually by abundant aquatic plant growth and algal blooms.

GLOSSARY CONTINUED

Extinction	In biology and ecology, extinction is the ceasing of existence of a species or group of taxons. The moment of extinction is generally considered to be the death of the last individual of that species.
Extirpation	To eliminate completely from a region.
Fauna	Animals.
Fetch	The distance along open water that wind travels unimpeded and in one direction.
Filamentous	Long, cylindrical, and threadlike.
Fish	Under Section 2 of the *Fisheries Act*, includes (a) parts of fish; (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals; and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.
Fish Habitat	Under the *Fisheries Act*, fish habitat includes the spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.
Fish Passage	Under the *Fisheries Act*, fish passage relates to the unimpeded and safe movement, upstream or downstream, of fish between aquatic habitats required to complete their life cycle.
Fishway	A constructed device or structure intended to provide for the passage of fish.
Flocculent	A fluid containing a mass formed by the aggregation of suspended particles.
Flora	Plants.
Flow (tide)	A rising tide. The transition from low tide to high tide.
Forage	The act of looking or searching for food or provisions.
Frazil Ice	Needle-shaped ice crystals that form an icy slush in the water.

GLOSSARY CONTINUED

Geodetic	Relates the geometry of exact positions of points and lines drawn on the earth's surface that make corrections for the curvature of the earth's surface. For example, geodetic elevation of the water surface, usually expressed in metres (m), is the exact vertical position of the waterline on the earth's surface and can be directly compared to other geodetic measurements.
Geomorphological	Relates to land and submarine relief features of the earth's surface.
Greenhouse Gases	Gaseous components of the atmosphere that contribute to global warming. Greenhouse gases include carbon dioxide, methane, nitrous oxide, and water vapour.
Gyre	A circular or spiral motion, especially a circular ocean current.
Hydrodynamics	Relates to the motion of fluids (usually water) and the forces that act on solid bodies immersed in fluids.
Hydrology	Study of the properties, distribution and circulation of water.
i.e.,	That is/In other words.
Impoundment	Natural or artificial body of water that is confined by a structure such as a dam to retain water, sediment, or wastes.
Indigenous	Originating and living or occurring naturally in an area or environment.
Intertidal	The region between the high tide mark and the low tide mark.
Littoral	Shallow shore area (less than 6 m) of a water body where light can usually penetrate to the bottom.
Meteorology	The science of weather and weather forecasting.
Microclimate	The local climate or weather conditions of usually a small site of habitat, such as higher temperatures in urban areas of a city due to heat release and reflection from vehicles, roads and buildings and strong winds channelling through gaps at the base of tall buildings. Variations of the climate within a given area, usually influenced by hills, hollows, structures or proximity to bodies of water.
Mitigation	Steps taken to avoid, or minimize negative environmental impacts.

Neap tide	A less than average tide occurring near the first and third quarters of the moon.
Palaeontological	Pertaining to fossil remains.
Palaeo-shorelines	Ancient shorelines.
Periphery	The outward bounds of something as distinguished from its internal regions or centre.
Photosynthesis	The process that a plant uses to combine sunlight, water and carbon dioxide to produce oxygen and carbohydrates (sugars).
Physiographic	The natural features of the earth's surface, especially in its current aspects, including land formation, climate, currents, and distribution of flora and fauna.
Pool-and-Orifice Fishway	Similar to a pool-and-weir fishway, in that individual pools are situated between an upstream and a downstream wall (weir). In a pool and orifice facility, water flows from upstream to downstream pools through a submerged hole (orifice) in the weir separating the two pools. Fish swim between the downstream and adjacent upstream pool through the orifice. Often there are two routes that fish can follow in pool-type fishways, through the submerged orifice, or in the flow over top of the weir separating the pools.
Pool-and-Weir Fishway	An engineered system to enable upstream fish passage. Pools are created by a series of baffles or walls (weirs) over which a current of water flows. The top of the upstream weir is at a slightly higher elevation than that of the downstream weir, which creates a slope that upstream-migrating fish must overcome. The floors of adjacent pools have the same elevation difference as do the tops of adjacent weirs, which creates the same water depth in each pool. Fish swim through the current flowing over the weirs or jump over the baffles to get to the adjacent upstream pool.
Potential Alternatives to the Project	Replacement of the fishway and other modifications to the existing structure and the null or do nothing alternative (the Status Quo).
Pre-contact period	Referring to the period before Aboriginal people made contact with European settlers.
Pre-empt	Taking priority.

GLOSSARY CONTINUED

Progeny	Offspring or descendants considered as a group.
Project (the Project)	The proposed Project consists of the removal of the Eel River dam, including the earthen dyke, concrete water control structure, and ancillary infrastructure (*e.g.*, fish passage facilities).
Project Objectives	The Project Objectives include (a) long-term solution to fish passage; (b) establishment of conditions that lead to the natural re-establishment of saltmarsh wetlands upstream of the current dam; and (c) improvement of habitat for softshelled clams and other shellfish upstream and downstream of the Eel River dam.
Proliferation	To increase or spread at a rapid rate.
Proponent	The Department of Supply and Services (NBDSS), acting on behalf of the Province of New Brunswick, given the responsibility to manage the EIA study.
Quasi-equilibrium	Possessing some attributes of equilibrium.
Quiescent	Being quiet, still, or at rest; inactive.
Quiescent	Quiet, at rest, but not necessarily dormant, and having the potential for resumed activity.
Raptors	A bird of prey, such as an eagle or hawk.
Rarity Ranks (AC CDC ratings)	S1 – Extremely rare throughout its range in the province; S2 – Rare throughout its range in the province; S3 – Uncommon throughout it range in the province; and S4 – Usually widespread, fairly common throughout its range in the province.
Redox	A chemical process involving reduction and oxidation.
Reservoir	A natural or artificial impoundment where water is collected, sorted, regulated and released for human use.
Respiration	The physical and chemical processes by which an organism supplies its cells and tissues with the oxygen needed for metabolism and relieves them of the carbon dioxide formed in energy-producing reactions.

GLOSSARY CONTINUED

Responsible Authority	In relation to a project, means a federal authority that is required, pursuant to Subsection 11(1) of *CEAA*, to ensure that an environmental assessment of the Project is conducted.
Riparian	Related to or living on the bank of a natural watercourse or lake (*e.g.*, riparian vegetation).
Scour	To clear, dig, or remove by a powerful current of water.
Secchi Depth	Used to assess light penetration in water as an indication of trophic state of the water body.
Sediment	Fragmented material from weathered rocks and organic material that is suspended in, transported by and eventually deposited by water or air.
Semi-nomadic	One of a people whose living habits are largely nomadic but who plant some crops at a base point.
Shell Midden	A deposit containing shells, animal bones, and other refuse indicating the site of a prehistoric human settlement.
Silviculture	The care and cultivation of forest trees; forestry.
Spatial Boundaries	In the context of this EIA Report means geographical extent to which activities associated with the Project are anticipated to occur in the existing environment and the extent of existing or anticipated positive and negative environmental effects, including cumulative environmental effects, for each VEC.
Species at Risk	Species protected by species at risk or endangered species legislation. Specifically, those species listed as Endangered or Regionally Endangered under the NB *Endangered Species Act* and those listed as Extirpated, Endangered, Threatened, or Special Concern by the federal *Species at Risk Act*.
Stagnation	A body of standing water not flowing in a current or stream.
Status Quo	The current condition/existing dam remains unchanged (using present criteria for gate operations).
Stratified	To form, arrange, or deposit in layers.

GLOSSARY CONTINUED

Synchronization	To occur at the same time; be simultaneous.
Teleost fish	A bony fish, which includes nearly all the important food and game fish, and many aquarium fish.
Thalweg	Signifies the line drawn through the lowest points of a valley or water course in its downward slope and thus marks the natural bottom and direction of a watercourse.
Tidal Inlet	An opening along the shoreline where water extends at high tide.
Topographic	The configuration of a surface including its relief and the position of its natural and man-made features.
Trajectories	A chosen or taken course.
Tsunamis	Great sea waves produced by submarine earth movement or volcanic eruption.
Voracious	Having a huge appetite.
Weir	Notch or depression in a dam across or bordering a stream that controls and/or measures the flow of water.

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
AC CDC	Atlantic Canada Conservative Data Center
ADT	Atlantic Daylight Savings Time
AHG	Aboriginal Heritage Gardens
ATOM-ABS	AAS-Atomic Absorption spectrometry
BOD	Biochemical Oxygen Demand
CBC	Christmas Bird Count
CCME	Canadian Council of Ministers of the Environment
CEAA	*Canadian Environmental Assessment Act*
CN Rail	Canadian National Railway Company
CNR	Canadian National Railway Company, CN Rail
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service of Environment Canada
Dalhousie CHC	Dalhousie Community Health Centre
DFO	Fisheries and Oceans Canada
DHE	Department of Health and Wellness
DIWS	Dalhousie Industrial Water System
DO	Dissolved Oxygen
EC	Environment Canada
ECD	Electron Capture Detector

LIST OF ACRONYMS CONTINUED

EIA/EA	Environmental Impact Assessment/Environmental Effects Assessment
EMP	Environmental Management Plan
EPP	Environmental Protection Plan
ERBFN	Eel River Bar First Nation
ERC	Eel River Crossing
ESA	Environmentally Significant Area
GC	Gas Chromatography
GHG	Greenhouse Gas
GPS	Global Positioning System
GWP	Global Warming Potential
HADD	Harmful Alteration, Disruption, or Destruction
ICP-ES	Inductively Coupled Plasma-Emission Spectrometry
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
INAC	Indian and Northern Affairs Canada
IONCHROM	Ionchromatography
IPCC	Intergovernmental Panel on Climate Change
IR_SPEC	Infra-red Spectrometry
ISQG	Interim Sediment Quality Guidelines
LOS	Level of Service
Meq	milli-equivilant
MPN	Most Probable Number

LIST OF ACRONYMS CONTINUED

MSD	Mass Spectrometry Detector
n/a	not available, or not applicable
NB	The Province of New Brunswick
NBCSS	New Brunswick Culture and Sport Secretariat
NBDAFA	New Brunswick Department of Agriculture, Fisheries and Aquaculture
NBDELG	New Brunswick Department of the Environment and Local Government
NBDHW	New Brunswick Department of Health and Wellness
NBDNR	New Brunswick Department of Natural Resources
NBDOT	New Brunswick Department of Transportation
NBDOTP	New Brunswick Department of Tourism and Parks
NBDSS	New Brunswick Department of Supply and Services
NBENV	New Brunswick Department of Environment; formerly known as New Brunswick Department of the Environment and Local Government (NBDELG)
NBM	The New Brunswick Museum
NBWA	New Brunswick Water Authority
Nc	No CCME guideline established
NFPA	National Fire Protection Association
NS	Not Significant
NSA	Noise Sensitive Areas
NW	Northwest
PAH	Polycyclic aromatic hydrocarbons

LIST OF ACRONYMS CONTINUED

PCB	Polychlorinated Biphenyl
PC-TITRA	Potentiometric colourimetry-Titration
PDO	Property Damage Only
PEL	Probable Effects Level Guidelines
POLs	Petroleum, Oils and Lubricants
QC	Quebec
RA	Responsible Authority
RO	Reverse osmosis
RPC	Research Productivity Council
SARA	*Species at Risk Act*
SI	International System of Units, (symbol: SI)
SNB	Service New Brunswick
SOPs	Standard Operating Procedures
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOR	Terms of Reference
Total PCB	Measured as concentration of Arochlors (predominate type of PCBs in the environment)
TP	Total Phosphorus
TPM	Total Particulate Matter
TRC	Technical Review Committee
TSP	Total Suspended Particulate

LIST OF ACRONYMS CONTINUED

TSS	Total Suspended Sediments
TURBMETR	Turbidity meter
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
VECs	Valued Environmental Components (biophysical, social, or economic components)
WWTP	Wastewater Treatment Plant

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

LIST OF UNITS OF MEASURE

°C	degree Celsius
µ	micro
µg/L	microgram per litre
µg/m^3	microgram per cubic metre
µS/cm	micro-siemen per centimetre
‰	practical salinity units expressed as parts per thousand
cm	centimetre
g	gram
ha	hectares
HAZENUNI	hazenunit, equivalent to Apparent Colour
hr	hour
kg	kilogram
kg/year	kilogram per year
km	kilometre
kPa	kilo-Pascal
L	litre
L/s	litre per second
Leq	Equivalent Sound Pressure Level
m	metre
m/s	metres per second

LIST OF UNITS OF MEASURE CONTINUED

m^3	cubic metre
m^3/s	cubic metre per second
meq/L	milli-equivilant per litre (from page 74)
mg	milligram
mg/kg	milligram per kilogram
mg/L	milligram per litre
mL	milliliter
mm	millimetre
mN	magnitude
ng/L	nanogram per litre
NTU	Nephelometric Turbidity Unit
pH	A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.
ppm	parts per million
s	second
yr	year

CHEMICAL FORMULAS

$CaCO_3$	Calcium Carbonate
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
H_2S	Hydrogen Sulphide
N	Nitrogen
N_2O	Nitrous Oxide
NO_x	Nitrogen Oxides
P	Phosphate
SiO_2	Silicon Dioxide; Silica
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

TABLE OF CONTENTS

Page No.

EXECUTIVE SUMMARY i

CONCORDANCE TABLE xv

GLOSSARY xvii

LIST OF ACRONYMS xxvii

LIST OF UNITS OF MEASURE xxxiii

LIST OF CHEMICAL FORMULAS xxxv

1.0 INTRODUCTION 1
- 1.1 Project Overview 1
  - 1.1.1 The Eel River Dam 1
  - 1.1.2 History of Key Environmental Concerns Associated with the Eel River Dam 1
  - 1.1.3 Purpose of the Project 5
- 1.2 Regulatory Context of EIA 6
  - 1.2.1 Proponent 6
  - 1.2.2 New Brunswick EIA Regulation 6
  - 1.2.3 Canadian Environmental Assessment Act 7
  - 1.2.4 Purpose of EIA Report 7
- 1.3 Jacques Whitford Study Team 8

2.0 EIA METHODS AND SCOPE 9
- 2.1 Environmental Assessment Methods 9
  - 2.1.1 Scoping 9
  - 2.1.2 Data Collection 9
    - 2.1.2.1 Biophysical Investigation 10
    - 2.1.2.2 Socio-economic Investigation 10
    - 2.1.2.3 Hydrodynamic, Water Quality and Geomorphological Investigation 11
  - 2.1.3 Description of Pre-dam and Post-dam Environments 12
  - 2.1.4 Evaluation of the Existing Fishway and Potential Improvements to the Fishway Against the Project Objectives 12
  - 2.1.5 Development of the Project Description 12
  - 2.1.6 Description of the Future Anticipated Environment 12
  - 2.1.7 Environmental Effects Assessment 12
    - 2.1.7.1 Environmental Assessment Boundaries 12
    - 2.1.7.2 Criteria for the Determination of Significance 13
    - 2.1.7.3 Environmental Effects Analysis 13
    - 2.1.7.4 Accidents, Malfunctions and Unplanned Events 13
    - 2.1.7.5 Effects of the Environment on the Project 13
    - 2.1.7.6 Cumulative Environmental Effects 14
    - 2.1.7.7 Follow-up Program 14
    - 2.1.7.8 Summary and Conclusions 14

TABLE OF CONTENTS CONTINUED

2.2 Public Consultation, Scoping and Selection of Valued Environmental Components 14
2.2.1 Public, Regulatory, and Stakeholder Consultation, and Meetings with the Aboriginal Community 14
2.2.1.1 Regulatory Consultation 14
2.2.1.2 Public Consultation 15
2.2.1.3 Stakeholder Consultation 18
2.2.1.4 Aboriginal Community Meetings 19
2.2.1.5 Summary 20
2.2.2 Scope of the Project and the Assessment 20
2.2.2.1 Scope of the Project 20
2.2.2.2 Scope of the Assessment 21
2.2.3 Selection of Valued Environmental Components 21
3.0 DESCRIPTION OF THE ENVIRONMENT 25
3.1 Coastal and Oceanographic Overview 25
3.1.1 Pre-dam Conditions 25
3.1.2 Post-dam and Existing Conditions 26
3.2 Physical Characteristics of the Eel River Estuary 30
3.2.1 Hydrodynamics 30
3.2.1.1 Eel River Watershed and Freshwater Flow 30
3.2.1.1.1 Pre-dam Conditions 30
3.2.1.1.2 Post-dam and Existing Conditions 31
3.2.1.2 Impoundment and Estuary Below the Dam 31
3.2.1.2.1 Pre-dam Conditions 31
3.2.1.2.2 Post-dam and Existing Conditions 31
3.2.1.3 Eel River Dam and Water Control Structure 32
3.2.1.3.1 Pre-dam Conditions 32
3.2.1.3.2 Post-dam and Existing Conditions 32
3.2.2 Bathymetry 37
3.2.2.1 Pre-dam Conditions 37
3.2.2.2 Post-dam and Existing Conditions 38
3.2.3 Geomorphology 43
3.2.3.1 Pre-dam Conditions 43
3.2.3.2 Post-dam and Existing Conditions 44
3.2.4 Tidal Regime 45
3.2.4.1 Pre-dam Conditions 45
3.2.4.2 Post-dam and Existing Conditions 45
3.2.5 Flooding 46
3.2.5.1 Pre-dam Conditions 46
3.2.5.2 Post-dam and Existing Conditions 46
3.2.6 Ice Regime 47
3.2.6.1 Pre-dam Conditions 47

3.2.6.2 Post-dam and Existing Conditions 47
3.3 Atmospheric Environment 48
3.3.1 Climate 49
3.3.1.1 Pre-dam Conditions 49
3.3.1.2 Post-dam and Existing Conditions 52
3.3.2 Air Quality 57
3.3.2.1 Pre-dam Conditions 58
3.3.2.2 Post-dam and Existing Conditions 58
3.3.3 Sound Quality 61
3.3.3.1 Pre-dam Conditions 62
3.3.3.2 Post-dam and Existing Conditions 62
3.3.4 Odour 63
3.3.4.1 Pre-dam Conditions 63
3.3.4.2 Post-dam and Existing Conditions 63
3.4 Fish Habitat and Fish 64
3.4.1 Water Quality 64
3.4.1.1 Pre-dam Conditions 65
3.4.1.2 Post-dam and Existing Conditions 66
3.4.2 Sediment Quality 92
3.4.2.1 Pre-dam Conditions 92
3.4.2.2 Post-dam and Existing Conditions 92
3.4.3 Fish 107
3.4.3.1 Pre-dam Conditions 107
3.4.3.1.1 Diadromous Fish 107
3.4.3.1.2 Freshwater Fish Community 108
3.4.3.1.3 Estuarine and Marine Fish Species 108
3.4.3.2 Post-dam and Existing Conditions 109
3.4.3.2.1 Diadromous Fish 109
3.4.3.2.2 Fish Resident in the Impoundment 112
3.4.3.2.3 Aquatic Species of Special Conservation Concern 113
3.5 Terrestrial Environment 114
3.5.1 Wetlands and Riparian Vegetation 114
3.5.1.1 Pre-dam Conditions 115
3.5.1.2 Post-dam and Existing Conditions 115
3.5.1.3 Vascular Plant Species of Conservation Concern 116
3.5.2 Wildlife 123
3.5.2.1 Pre-dam Conditions 123
3.5.2.2 Post-dam and Existing Conditions 123
3.5.2.3 Wildlife Species of Conservation Concern 124
3.6 Migratory Birds 124
3.6.1 Pre-dam Conditions 124
3.6.2 Post-dam and Existing Conditions 125

TABLE OF CONTENTS CONTINUED

3.6.3 Species of Conservation Concern 134
3.6.4 Ecologically Sensitive and Protected Areas 135
3.7 Species at Risk 135
3.7.1 Aquatic Species 135
3.7.2 Vascular Plants 135
3.7.3 Wildlife 135
3.7.4 Migratory Birds 136
3.8 Water Resources 139
3.8.1 Groundwater 139
3.8.1.1 Surficial Geology 140
3.8.1.1.1 Pre-dam Conditions 140
3.8.1.1.2 Post-dam and Existing Conditions 140
3.8.1.2 Bedrock Geology 140
3.8.1.2.1 Pre-dam Conditions 140
3.8.1.2.2 Post-dam and Existing Conditions 141
3.8.1.3 Hydrogeology 141
3.8.1.3.1 Pre-dam Conditions 141
3.8.1.3.2 Post-dam and Existing Conditions 142
3.8.1.4 Groundwater Use 142
3.8.1.4.1 Pre-dam Conditions 142
3.8.1.4.2 Post-dam and Existing Conditions 142
3.8.1.5 Groundwater Availability 143
3.8.1.5.1 Pre-dam Conditions 143
3.8.1.5.2 Post-dam and Existing Conditions 143
3.8.2 Surface Water 143
3.8.2.1 Surface Water Use 143
3.8.2.1.1 Pre-dam Conditions 143
3.8.2.1.2 Post-dam and Existing Conditions 144
3.8.2.2 Surface Water Availability 147
3.8.2.2.1 Pre-dam Conditions 147
3.8.2.2.2 Post-dam and Existing Conditions 148
3.8.3 Water Resources Infrastructure 151
3.8.3.1 Industrial and Municipal Water Supply Infrastructure 151
3.8.3.1.1 Pre-dam Conditions 151
3.8.3.1.2 Post-dam and Existing Conditions 151
3.8.3.2 Wastewater Treatment Infrastructure 152
3.8.3.2.1 Pre-dam Conditions 152
3.8.3.2.2 Post-dam and Existing Conditions 155
3.9 Vessel Navigation 155
3.9.1.1 Pre-dam Conditions 156
3.9.1.2 Post-dam and Existing Conditions 156
3.10 Transportation Network 157

3.10.1 Traffic Patterns 157
  3.10.1.1 Pre-dam Conditions 157
  3.10.1.2 Post-dam and Existing Conditions 158
3.10.2 Road Infrastructure 159
  3.10.2.1 Pre-dam Conditions 159
  3.10.2.2 Post-dam and Existing Conditions 159
3.11 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons 160
3.11.1 Fisheries 161
  3.11.1.1 Pre-dam Conditions 161
  3.11.1.2 Existing Conditions 161
3.11.2 Trapping and Hunting 162
  3.11.2.1 Pre-dam Conditions 162
  3.11.2.2 Existing Conditions 162
3.11.3 Plant Gathering 165
  3.11.3.1 Pre-Dam Conditions 165
  3.11.3.2 Existing Conditions 165
3.11.4 Recreation 166
  3.11.4.1 Pre-dam Conditions 166
  3.11.4.2 Existing Conditions 166
3.11.5 Transportation 167
  3.11.5.1 Pre-dam Conditions 167
  3.11.5.2 Existing Conditions 167
3.11.6 Residential Use 167
  3.11.6.1 Pre-dam Conditions 167
  3.11.6.2 Existing Conditions 168
3.11.7 Summary 168
  3.11.7.1 Pre-dam Conditions 168
  3.11.7.2 Existing Conditions 168
3.12 Tourism and Recreation 168
3.12.1 Tourism 169
  3.12.1.1 Pre-dam Conditions 169
  3.12.1.2 Post-dam Conditions 169
3.12.2 Recreation 171
  3.12.2.1 Pre-dam Conditions 171
  3.12.2.2 Post-dam Conditions 171
3.13 Labour and Economy 172
3.13.1 Demographics, Labour Force and Economic Overview 175
  3.13.1.1 Pre-dam Conditions 175
  3.13.1.2 Post-dam and Existing Conditions 175
3.13.2 Commercial Fisheries Resources 177
  3.13.2.1 Pre-dam Conditions 177

TABLE OF CONTENTS CONTINUED

3.13.2.2 Post-dam and Existing Conditions 178
3.14 Archeological and Heritage Resources 180
3.14.1 Pre-dam Conditions 180
3.14.2 Existing Conditions 182
3.15 Public Health and Safety 183
3.15.1 Flooding and Flood Risk 183
3.15.1.1 Pre-dam Conditions 183
3.15.1.2 Post-dam and Existing Conditions 183
3.15.2 Bacteriological Environment 184
3.15.2.1 Pre-dam Conditions 184
3.15.2.2 Post-dam and Existing Conditions 185
3.15.3 Food Resource Contamination 190
3.15.3.1 Pre-dam Conditions 190
3.15.3.2 Post-dam and Existing Conditions 190
4.0 EVALUATION OF EXISTING FISHWAY AND POTENTIAL IMPROVEMENTS TO THE FISHWAY AGAINST THE FISH PASSAGE PROJECT OBJECTIVE 197
4.1 Fish Passage Project Objective 197
4.1.1 Requirements of Fish Species for Passage 197
4.1.2 Description of Existing Fishway 199
4.1.3 Effectiveness of Existing Fishway 200
4.1.4 Potential Fishway Improvements to Promote Improved Fish Passage 206
4.1.4.1 Performance Issues 206
4.1.4.2 Potential Improvements to Fishway 207
4.1.4.2.1 Lower the Drop Between the Lower Pools 207
4.1.4.2.2 Deepen the Existing Pools 207
4.1.4.2.3 Install More Pools on the Upstream Side of the Fishway 207
4.1.4.2.4 Employ Multiple Exits to Allow for Variable Water Height in the Impoundment 208
4.1.4.2.5 Incorporate Streaming Rather than Plunging Flow Over Weirs. 208
4.1.4.2.6 Attempt to Accommodate Rainbow Smelt 213
4.1.4.2.7 Provide Attraction Flow 213
4.1.4.3 Other Existing Fish Passage Issues 213
4.1.5 Summary 214
5.0 PROJECT DESCRIPTION AND IMPLEMENTATION STRATEGY 215
5.1 The Project 216
5.1.1 Stage 1 – Design, Permitting, Planning and Communication 216
5.1.1.1 Design 216
5.1.1.2 Permitting and Planning 217
5.1.1.3 Communication 217
5.1.2 Stage 2 – Create a 150 m-Wide Opening in the Dam 217

TABLE OF CONTENTS CONTINUED

5.1.3 Stage 3 – Remove Remainder of Dam 223
5.1.4 Alternative Means of Carrying Out the Project 224
5.1.4.1 Alternative Methods for Removing the Dam 224
5.1.4.2 Alternative Methods for Removing the Control Structure 224
5.1.4.3 Alternative Erosion and Sediment Control Measures 224
5.2 Schedule 229
5.3 Accidents, Malfunctions and Unplanned Events 229
5.3.1 Hazardous Material Spills 229
5.3.2 Unplanned Erosion 230
5.4 Environmental Management Plan 230
5.4.1 Environmental Protection Plan 231
5.4.2 Follow-up Program 232
6.0 PREDICTED FUTURE ENVIRONMENT 233
6.1 Hydrodynamic Conditions 233
6.1.1 Hydrodynamic Modelling Objectives 233
6.1.2 Hydrodynamic Modelling Scenarios 233
6.1.3 Hydrodynamic Modelling for Existing Conditions 234
6.1.4 Hydrodynamic Modelling Results 237
6.2 Water Quality 243
6.2.1 Dissolved Oxygen 243
6.2.2 Biochemical Oxygen Demand 243
6.2.3 Nutrients 244
6.2.4 Salinity 245
6.3 Geomorphology 245
6.4 Ice Regime 249
7.0 ENVIRONMENTAL EFFECTS ASSESSMENT 251
7.1 Atmospheric Environment 251
7.1.1 Rationale for Selection of VEC 251
7.1.2 Boundaries 251
7.1.3 Threshold for Determination of Significance 252
7.1.3.1 Climate 252
7.1.3.2 Air Quality 252
7.1.3.3 Sound Quality 253
7.1.3.4 Odour 253
7.1.4 Evaluation of Potential Environmental Effects 253
7.1.4.1 Status Quo 253
7.1.4.1.1 Climate 253
7.1.4.1.2 Air Quality 254
7.1.4.1.3 Sound Quality 254
7.1.4.1.4 Odour 255
7.1.4.2 The Project 256
7.1.4.2.1 Climate 256

TABLE OF CONTENTS CONTINUED

7.1.4.2.2 Air Quality 258
7.1.4.2.3 Sound Quality 258
7.1.4.2.4 Odour 259
7.1.5 Accidents, Malfunctions and Unplanned Events 260
7.2 Fish Habitat and Fish 260
7.2.1 Rationale for Selection of VEC 260
7.2.2 Boundaries 260
7.2.3 Threshold for Determination of Significance 261
7.2.3.1 Fish Habitat 261
7.2.3.2 Fish 261
7.2.4 Evaluation of Potential Environmental Effects 262
7.2.4.1 Status Quo 262
7.2.4.1.1 Fish Habitat 262
7.2.4.1.2 Fish 263
7.2.4.2 The Project 263
7.2.4.2.1 Fish Habitat 263
7.2.4.2.2 Fish 264
7.2.5 Accidents, Malfunctions and Unplanned Events 265
7.3 Terrestrial Environment 265
7.3.1 Rationale for Selection of VEC 265
7.3.1.1 Wetland and Vegetation 265
7.3.1.2 Wildlife 266
7.3.2 Boundaries 266
7.3.3 Threshold for Determination of Significance 267
7.3.3.1 Wetland 267
7.3.3.2 Vegetation 267
7.3.3.3 Wildlife 267
7.3.4 Evaluation of Potential Environmental Effects 268
7.3.4.1 Status Quo 268
7.3.4.1.1 Wetland and Vegetation 268
7.3.4.1.2 Wildlife 269
7.3.4.2 The Project 270
7.3.4.2.1 Wetland and Vegetation 270
7.3.4.2.2 Wildlife 272
7.3.5 Accidents, Malfunctions and Unplanned Events 272
7.3.5.1 Wetland and Vegetation 272
7.3.5.2 Wildlife 273
7.4 Migratory Birds 273
7.4.1 Rationale for Selection of VEC 273
7.4.2 Boundaries 273
7.4.3 Threshold for Determination of Significance 274
7.4.4 Evaluation of Potential Environmental Effects 274

TABLE OF CONTENTS CONTINUED

7.4.4.1 Status Quo 274
7.4.4.2 The Project 275
7.4.5 Accidents, Malfunctions and Unplanned Events 276
7.5 Species at Risk 276
7.5.1 Rationale for Selection of VEC 276
7.5.2 Boundaries 277
7.5.3 Threshold for Determination of Significance 277
7.5.4 Evaluation of Potential Environmental Effects 277
7.5.4.1 Status Quo 277
7.5.4.2 The Project 279
7.5.5 Accidents, Malfunctions and Unplanned Events 279
7.6 Water Resources 280
7.6.1 Rationale for Selection of VEC 280
7.6.1.1 Surface Water 280
7.6.1.2 Water Resources Infrastructure 280
7.6.2 Boundaries 281
7.6.3 Threshold for Determination of Significance 281
7.6.4 Evaluation of Potential Environmental Effects 281
7.6.4.1 Status Quo 281
7.6.4.1.1 Surface Water 281
7.6.4.1.2 Water Resources Infrastructure 283
7.6.4.2 The Project 283
7.6.4.2.1 Surface Water 283
7.6.4.2.2 Water Resources Infrastructure 284
7.6.5 Accidents, Malfunctions and Unplanned Events 284
7.7 Vessel Navigation 285
7.7.1 Rationale for Selection of VEC 285
7.7.2 Boundaries 285
7.7.3 Threshold for Determination of Significance 285
7.7.4 Evaluation of Potential Environmental Effects 285
7.7.4.1 Status Quo 285
7.7.4.1.1 Vessel Navigation Above the Dam 285
7.7.4.1.2 Vessel Navigation at the Dam 285
7.7.4.1.3 Vessel Navigation Below the Dam 286
7.7.4.1.4 Vessel Navigation Overall 286
7.7.4.2 The Project 286
7.7.4.2.1 Vessel Navigation Above the Dam 286
7.7.4.2.2 Vessel Navigation At the Dam 287
7.7.4.2.3 Vessel Navigation Below the Dam 287
7.7.4.2.4 Vessel Navigation Overall 287
7.7.5 Accidents, Malfunctions and Unplanned Events 287
7.8 Transportation Network 287

7.8.1 Rationale for Selection of VEC 287
7.8.2 Boundaries 288
7.8.3 Threshold for Determination of Significance 288
7.8.4 Evaluation of Potential Environmental Effects 288
7.8.4.1 Status Quo 288
7.8.4.2 The Project 288
7.8.5 Accidents, Malfunctions and Unplanned Events 290
7.9 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons 290
7.9.1 Rationale for Selection of VEC 290
7.9.2 Boundaries 290
7.9.3 Threshold for Determination of Significance 291
7.9.4 Evaluation of Potential Environmental Effects 291
7.9.4.1 Status Quo 291
7.9.4.2 The Project 292
7.9.5 Accidents, Malfunctions and Unplanned Events 292
7.10 Tourism and Recreation 293
7.10.1 Rationale for Selection of VEC 293
7.10.2 Boundaries 293
7.10.3 Threshold for Determination of Significance 294
7.10.4 Evaluation of Potential Environmental Effects 294
7.10.4.1 Status Quo 294
7.10.4.2 The Project 295
7.10.5 Accidents, Malfunctions or Unplanned Events 296
7.11 Labour and Economy 297
7.11.1 Rationale for Selection of VEC 297
7.11.2 Boundaries 297
7.11.3 Threshold for Determination of Significance 297
7.11.4 Evaluation of Potential Environmental Effects 298
7.11.4.1 Status Quo 298
7.11.4.2 The Project 298
7.11.5 Accidents, Malfunctions and Unplanned Events 299
7.12 Archaeological and Heritage Resources 299
7.12.1 Rationale for Selection of VEC 299
7.12.2 Boundaries 300
7.12.3 Threshold for Determination of Significance 300
7.12.4 Evaluation of Potential Environmental Effects 300
7.12.4.1 Status Quo 300
7.12.4.2 The Project 301
7.12.5 Accidents, Malfunctions and Unplanned Events 302
7.13 Public Health and Safety 302
7.13.1 Rationale for Selection of VEC 302

7.13.1.1 Flooding and Flood Risk 303
7.13.1.2 Bacteriological Environment 303
7.13.1.3 Food Resource Contamination 303
7.13.2 Boundaries 303
7.13.3 Threshold for Determination of Significance 303
7.13.3.1 Flooding and Flood Risk 303
7.13.3.2 Bacteriological Environment 304
7.13.3.3 Food Resource Contamination 304
7.13.4 Evaluation of Potential Environmental Effects 304
7.13.4.1 Status Quo 304
7.13.4.1.1 Flooding and Flood Risk 304
7.13.4.1.2 Bacteriological Environment 305
7.13.4.1.3 Food Resource Contamination 305
7.13.4.2 The Project 306
7.13.4.2.1 Flooding and Flood Risk 306
7.13.4.2.2 Bacteriological Environment 306
7.13.4.2.3 Food Resource Contamination 307
7.13.5 Accidents, Malfunctions and Unplanned Events 307
7.13.5.1 Flooding and Flood Risk 307
7.13.5.2 Bacteriological Environment 308
7.13.5.3 Food Resource Contamination 308
8.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT 309
8.1 Background 309
8.2 Threshold for Determination of Significance 309
8.3 Evaluation of the Potential Effects of the Environment 309
8.3.1 Status Quo 309
8.3.1.1 Sediment Transport Process 310
8.3.1.2 Tidal Prism 310
8.3.1.3 Weather (Precipitation, Temperature and Wind) 310
8.3.1.4 Flooding 310
8.3.1.5 Storm Surge 310
8.3.1.6 Waves 310
8.3.1.7 Ice 311
8.3.1.8 Climate Change 311
8.3.1.9 Earthquake Activity 312
8.3.2 The Project 312
8.3.2.1 Sediment Transport Process 313
8.3.2.2 Tidal Prism 313
8.3.2.3 Weather (Precipitation, Temperature and Wind) 313
8.3.2.4 Flooding 313
8.3.2.5 Ice 313
8.3.2.6 Climate Change 313

8.3.2.7 Earthquake Activity 314
8.3.3 Comparative Assessment 314
9.0 CUMULATIVE ENVIRONMENTAL EFFECTS ANALYSIS 315
9.1 Methods and Scope 315
9.2 Summary of the Environmental Effects of the Status Quo and the Project 317
9.3 The Environmental Effects of Other Actions That May Overlap Those of the Project 320
9.3.1 Cumulative Environmental Effects Assessment Boundaries 320
9.3.2 Cumulative Environmental Effects Thresholds for Determination of Significance 320
9.3.3 Selection of Projects That Will be Carried Out 320
9.4 Identification of Potential Cumulative Environmental Effects 321
9.5 Evaluation of Potential Cumulative Environmental Effects 322
9.5.1 Fish Habitat and Fish 322
9.5.1.1 Status Quo 322
9.5.1.2 The Project 323
9.5.2 Terrestrial Environment 323
9.5.2.1 Status Quo 324
9.5.2.2 The Project 324
9.5.3 Migratory Birds 325
9.5.3.1 Status Quo 325
9.5.3.2 The Project 325
9.5.4 Species at Risk 325
9.5.4.1 Status Quo 325
9.5.4.2 The Project 325
9.5.5 Transportation Network 326
9.5.5.1 Status Quo 326
9.5.5.2 Project 326
9.5.6 Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons 326
9.5.6.1 Status Quo 327
9.5.6.2 The Project 327
9.5.7 Tourism and Recreation 328
9.5.7.1 Status Quo 328
9.5.7.2 The Project 328
9.5.8 Labour and Economy 328
9.5.8.1 Status Quo 328
9.5.8.2 The Project 329
9.5.9 Heritage and Archaeological Resources 329
9.5.9.1 Status Quo 329
9.5.9.2 The Project 329
9.5.10 Public Health and Safety 330

9.5.10.1 Status Quo 330
9.5.10.2 The Project 330
9.6 Recommended Mitigation for Potential Cumulative Environmental Effects 330
10.0 FOLLOW-UP PROGRAM 331
10.1 Requirements 331
10.2 Recommendations 331
10.2.1 Atmospheric Environment 332
10.2.2 Fish Habitat and Fish 332
10.2.3 Terrestrial Environment 332
10.2.4 Migratory Birds 332
10.2.5 Species at Risk 333
10.2.6 Water Resources 333
10.2.7 Vessel Navigation 333
10.2.8 Transportation Network 333
10.2.9 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons 333
10.2.10 Tourism and Recreation 334
10.2.11 Labour and Economy 334
10.2.12 Heritage and Archaeological Resources 334
10.2.13 Public Health and Safety 334
10.3 Implementation 335
11.0 SUMMARY AND CONCLUSIONS 337
11.1 Introduction 337
11.2 Project Objectives 337
11.3 EIA Methods and Scope 337
11.4 Description of Existing Environment 337
11.5 Evaluation of Existing Fishway and Potential Improvements to the Fishway Against the Project Objectives 337
11.6 Project Description 338
11.7 Predicted Future Environment 338
11.8 Analysis of the Net Positive and Negative Effects of the Status Quo and the Project 339
11.8.1 Atmospheric Environment 339
11.8.1.1 Climate 339
11.8.1.2 Air Quality 339
11.8.1.3 Sound Quality 339
11.8.1.4 Odour 339
11.8.2 Fish Habitat and Fish 340
11.8.2.1 Fish Habitat 340
11.8.2.2 Fish 340
11.8.3 Terrestrial Environment 341
11.8.3.1 Wetland and Vegetation 341

TABLE OF CONTENTS CONTINUED

11.8.3.1.1 Wetland 341
11.8.3.1.2 Vegetation 341
11.8.3.2 Wildlife 342
11.8.4 Migratory Birds 342
11.8.5 Species at Risk 342
11.8.6 Water Resources 343
11.8.6.1 Surface Water 343
11.8.6.2 Water Resources Infrastructure 343
11.8.7 Vessel Navigation 343
11.8.8 Transportation Network 344
11.8.9 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons 344
11.8.10 Tourism and Recreation 344
11.8.11 Labour and Economy 345
11.8.12 Heritage and Archaeological Resources 345
11.8.13 Public Health and Safety 346
11.8.13.1 Flooding and Flood Risk 346
11.8.13.2 Bacteriological Environment 346
11.8.13.3 Food Resource Contamination 346
11.8.14 Accidents, Malfunctions and Unplanned Events 347
11.9 Effects of the Environment on the Project 347
11.10 Cumulative Environmental Effects Analysis 348
11.11 Follow-up and Monitoring Program 349
11.12 Overall Conclusion 349
12.0 REFERENCES 351
12.1 Personal Communications 351
12.2 Literature Cited 353

LIST OF TABLES

Page No.
Table 1.3.1 Jacques Whitford Study Team 8
Table 2.2.1 Summary of Issues, Concerns and Comments from Open Houses, December 7 and 8, 2004 and November 8 and 9, 2005 15
Table 2.2.2 Issues/Concerns Raised During Stakeholder Meetings 18
Table 2.2.3 Issues/Concerns Raised During ERBFN Meetings 20
Table 2.2.4 Valued Environmental Components 23
Table 3.2.1 The Geodetic Elevations of the Characteristic Tides in Eel Bay as Reported by Canadian Hydrographic Service 45
Table 3.3.1 Campbellton Monthly Climate Normals (1945-1963) and Extremes 51
Table 3.3.2 Charlo Airport Monthly Climate Normals (1971-2000) and Extremes 54
Table 3.3.3 New Brunswick and Assessment Area Population Counts by Census Year 57
Table 3.3.4 Greenhouse Gas Emissions – Existing (2005) Estimates 57
Table 3.3.5 Air Contaminant Emissions – Estimates for the Assessment Area for Existing (2005) Conditions 59
Table 3.3.6 Canadian and New Brunswick Ambient Air Quality Objectives for Selected Air Contaminants 60
Table 3.3.7 Summary of Ambient Air Quality Monitoring Data (1998-2003) 61
Table 3.4.1 Water Quality Sampling Results at Eel River Crossing (May 17, 1962) 65
Table 3.4.2 General Water Quality Chemistry in the Eel River Area in 2004 73
Table 3.4.3 Results of General Chemistry Analysis in the Water at Station TD1 (U1) in 2005. 74
Table 3.4.4 Trace Metals of Water Samples from the Eel River Area in 2004 76
Table 3.4.5 Results of Trace Metals Analysis in the Water at Station TD1 (U1) in 2005. 77
Table 3.4.6 Water Column Profiling Data in the Eel River Area, 2004 97
Table 3.4.7 Water Column Profiling Data in the Eel River Area, 2005 100
Table 3.4.8 Grain Size, Ammonia, and TOC Analysis of Sediment from the Eel River Area, June 28-29, 2004 102
Table 3.4.9 Trace Metals Analysis in Sediment from the Eel River Area, June 28-29, 2004 103
Table 3.4.10 PAHs and Total PCBs in Sediment from the Eel River Area, June 28-29, 2004 107
Table 3.4.11 Estuarine and Marine Fish Species that May Occur in the Eel River Estuary/Eel Bay 109
Table 3.4.12 Results of 2004 Resident Fish Survey in the Eel River Impoundment 113
Table 3.5.1 Definitions of AC CDC Rarity Ranks and NBDNR General Status Ranks 116
Table 3.5.2 Plant Species Recorded During the August 2004 Survey 119
Table 3.6.1 Results of Migratory Bird Survey at Eel River Impoundment, June 2004 126
Table 3.6.2 Results of Migratory Bird Survey, September 2005 129
Table 3.6.3 Compilation of Migratory Bird Observations in Area of Eel River Impoundment, 1969 to Present 130
Table 3.10.1 Summary of Accident Occurrence by Severity - Assessment Area Highways (1999-2003) 159
Table 3.13.1 Demographic Profile of Eel River Assessment Area 175

LIST OF TABLES CONTINUED

Table 3.13.2 Economic Labour Force Profile of Eel River Assessment Area 176
Table 3.13.3 Estimated Landings of Softshell Clams (kg) at Eel River Cove, New Brunswick, 1959 to 1962 178
Table 3.13.4 Comparative Numbers and Weight of Clams, 1963, 1964 and 1967 179
Table 3.13.5 Summary of Clam Standing Crops in the estuary below the dam 179
Table 3.15.1 Summary Statistics of Fecal Coliform Concentrations (Most Probable Number/100 mL) for Eel River 187
Table 3.15.2 Bacteriological Analyses of Water Samples from the Eel River Area in 2004. 188
Table 3.15.3 Bacteriological Analyses of Water Samples for Station TD1 (U1) in 2005 188
Table 3.15.4 Results of Tissue Analysis in Fish and Softshell Clams from the Eel River Area in 2005. 195
Table 4.1.1 Swimming Abilities of Fish Species that Require Fish Passage 199
Table 4.1.2 Elevations and Water Depths of Improved Eel River Pool and Weir Fishway 208
Table 5.1.1 Capital Costs of Project 216
Table 5.4.1 Proposed Table of Contents, Environmental Protection Plan 231
Table 6.1.1 Summary of Hydrodynamic Modelling Results for Evaluating Tidal Inlet 235
Table 6.1.2 Summary of Hydrodynamic Modelling Scenarios and Modelling Results for Future Conditions 236
Table 6.2.1 Summary of Increase in Dilution and Reduction in Travel Time in Impoundment as a Result of Dam Removal 245
Table 9.1.1 Cumulative Environmental Effects Considered In Previous Chapters 315
Table 9.2.1 Summary and Comparison of Key Environmental Effects of the Status Quo and Project 318
Table 9.3.1 Other Future Projects For Consideration of Cumulative Environmental Effects 321
Table 9.4.1 Cumulative Environmental Effects Interaction Matrix 322

LIST OF FIGURES

Figure 1.1.1 General Site Location Map 3
Figure 3.1.1 Water Depths in Eel Bay 27
Figure 3.2.1 Monthly Flow Distribution at Eel River Dam 33
Figure 3.2.2 A 1995 Aerial Photograph of the Lower Portion of the Estuary of Eel River 35
Figure 3.2.3 A 2005 Aerial Photograph of the Lower Portion of the Estuary of Eel River 39
Figure 3.2.4 Location of Sediment Sampling Stations and Sections in 2004 41
Figure 3.3.1 Wind Speed and Wind Direction Annual Average Joint Frequency Distribution – (Charlo Airport 1994-1997) 55
Figure 3.4.1 A 1997 Aerial Photo Showing Upper Portion of the Impoundment 69
Figure 3.4.2 Location of Water Sampling Stations in 2004 and 2005 71
Figure 3.4.3 Surface and Bottom Conductivity Levels Measured in 2004 at Different Distances Upstream of the Eel River Dam 79
Figure 3.4.4 Surface and Bottom Dissolved Oxygen Levels Measured in 2004 at Different Distances Upstream of the Eel River Dam 81
Figure 3.4.5 Surface and Bottom Temperatures Measured in 2004 at Different Distances Upstream of the Eel River Dam 83
Figure 3.4.6 Surface and Bottom Conductivity Levels Measured in 2005 at Different Distances Upstream of the Eel River Dam 85
Figure 3.4.7 Surface and Bottom Dissolved Oxygen Levels Measured in 2005 at Different Distances Upstream of the Eel River Dam 87
Figure 3.4.8 Surface and Bottom Temperatures Measured in 2005 at Different Distances Upstream of the Eel River Dam 89
Figure 3.4.9 Water Temperature of the Eel River Impoundment in 2005 as Measured by NB Power at the Dalhousie Generating Station 93
Figure 3.4.10 Conductivity of Water Pumped From the Eel River Impoundment in 2005 and Measured by NB Power at the Dalhousie Generating Station 95
Figure 3.4.11 Location of Sediment Sampling Stations 2004 105
Figure 3.4.12 Fyke Net Locations on Eel River August 2004 115
Figure 3.5.1 Locations of Salt Marshes Delineated From 1963 Aerial Photography of the Eel River Estuary 117
Figure 3.5.2 Locations of Rare Vascular Plants and Marshes Identified in August 2004 and Delineation of Post-Dam Marshes from August 2005 Aerial Photography in the Eel River Impoundment and Estuary 121
Figure 3.6.1 Migratory Birds Survey Zones in 2004 and 2005 in the Eel River Impoundment, Estuary and Bay 127
Figure 3.7.1 Photo of Semipalmated Plover Observed on the Exposed Bottom of the Impoundment 137
Figure 3.8.1 Water Resources and Transportation Infrastructure 153
Figure 3.11.1 Past and Current Use of Land and Resources for Traditional Purposes by the Aboriginal Community 163

LIST OF FIGURES CONTINUED

Figure 3.12.1 Tourism and Recreation Facilities 171
Figure 3.13.1 Municipal Boundaries 173
Figure 3.15.1 Environment Canada Fecal Coliform Sampling Station Locations in the Eel River Area 191
Figure 4.1.1 Eel River Dam Control Structure and Fishway Photo 201
Figure 4.1.2 Fishway Section 203
Figure 4.1.3 Pool and Weir Fishway with High and Low Level 209
Figure 4.1.4 Plunging Versus Streaming Fishway Flow (Clay, 1955) 211
Figure 5.1.1 Stage 2 Preparatory Work Plan and Profile 219
Figure 5.1.2 Stage 2 Construction Methodology Plan and Profile 221
Figure 5.1.3 Stage 3 Remove Remainder of Dam Plan and Profile 227
Figure 6.1.1 Camparison of Water Level in the Impoundment 239
Figure 6.1.2 High Water Line in the Impoundment for Large Tide with Full Removal of the Eel River Dam 241
Figure 6.3.1 Elevation and Storage Curves 247

LIST OF APPENDICIES

Appendix A	EIA Guidelines
Appendix B	Supplementary Hydrodynamic and Geomorphological Investigation Information
Appendix C	Plant Species List for the Freshwater Impoundment and Salt Marsh Downstream from the Dam
Appendix D	Cross Section and Sediment Information

1.0 INTRODUCTION

This document is the Environmental Impact Assessment (EIA) Report for the removal of Eel River dam (the "Project"). This section provides an introduction to the proposed Project, a history of environmental concerns associated with the Eel River dam, the purpose of the Project, and the regulatory context of the EIA.

1.1 Project Overview

The Project is the Decommissioning or removal of the Eel River dam, including the earthen dyke, concrete water control structure, and ancillary infrastructure (*e.g.*, fish passage facilities).

1.1.1 The Eel River Dam

The Eel River dam is located in Restigouche County south of the Town of Dalhousie, approximately 600 m upstream of New Brunswick Route 134 at Eel River bar (Figure 1.1.1). The dam was built in 1963 by the Town of Dalhousie to provide an industrial water source (non-potable) for the area. Route 134 and its bridge over Eel River bar were constructed seven years prior to the Eel River dam. The responsibility for the dam lies with New Brunswick Department of the Environment (NBENV). The Town of Dalhousie operates and maintains the dam under contract with NBENV.

1.1.2 History of Key Environmental Concerns Associated with the Eel River Dam

The history of key environmental concerns associated with the Eel River dam were outlined in a report prepared for NBENV titled *Assessment of the Impact of Removing the Eel River Dam on the Development of Environmental, Economic, and Social Benefit from the Eel River* (BMA and CG&S, 2000). The following discussion is largely based on key information contained in that report. There are many other environmental concerns associated with the Eel River dam than those mentioned in this section. Chapter 3 in this EIA Report presents a more thorough discussion of past and present environmental conditions in the Eel River watershed and documents those concerns in more detail.

Historically, the Eel River estuary was the transition zone between the saltwater environment of Eel Bay and the freshwater environment of the Eel River and its tributaries. Prior to the construction of the Eel River dam (commenced in 1963), the currently impounded area formed part of the Eel River estuary. Tidal flow from Eel Bay reached the Village of Eel River Crossing. The tidal exchange was dynamic and the related sediment transport and deposition was in equilibrium as an estuarine system. The tides provided an effective flushing mechanism for the estuary.

The Eel River estuary transition zone provided a brackish water habitat for fresh and saltwater aquatic life, a habitat that is usually high in aquatic diversity (BMA and CG&S, 2000). Species that have thrived in Eel River include, but are not limited to, the American eel (*Anguilla rostrata*) and the Atlantic salmon

(*Salmo salar*), rainbow smelt (*Osmerus mordax*) and the migratory phase (sea-run) of the brook trout (*Salvelinus fontinalis*). The dynamic estuarine environment that existed prior to the construction of the dam provided a range of habitats for a diversity of species during portions of their life cycle. Since dam construction, which lead to the loss of several habitat types in the estuary, created a freshwater environment above the dam, and limited the ability of fish to pass through the dam, many of these species are no longer able to survive in this system.

Following construction of the dam in 1963, there was no longer any opportunity for saltwater to flow upstream past the dam and all but the lower 600 m of the estuary was lost. The natural flushing mechanism for the consequent freshwater impoundment was greatly modified. The creation of a freshwater impoundment above the dam and the modifications to water levels resulted in marked changes to the character of the river and its associated ecological community. Changes in flow (lack of tidal influences), salinity, sediment deposition patterns, water temperature, water quality, and evaporation rates caused the impoundment to be more "lake-like" than a river.

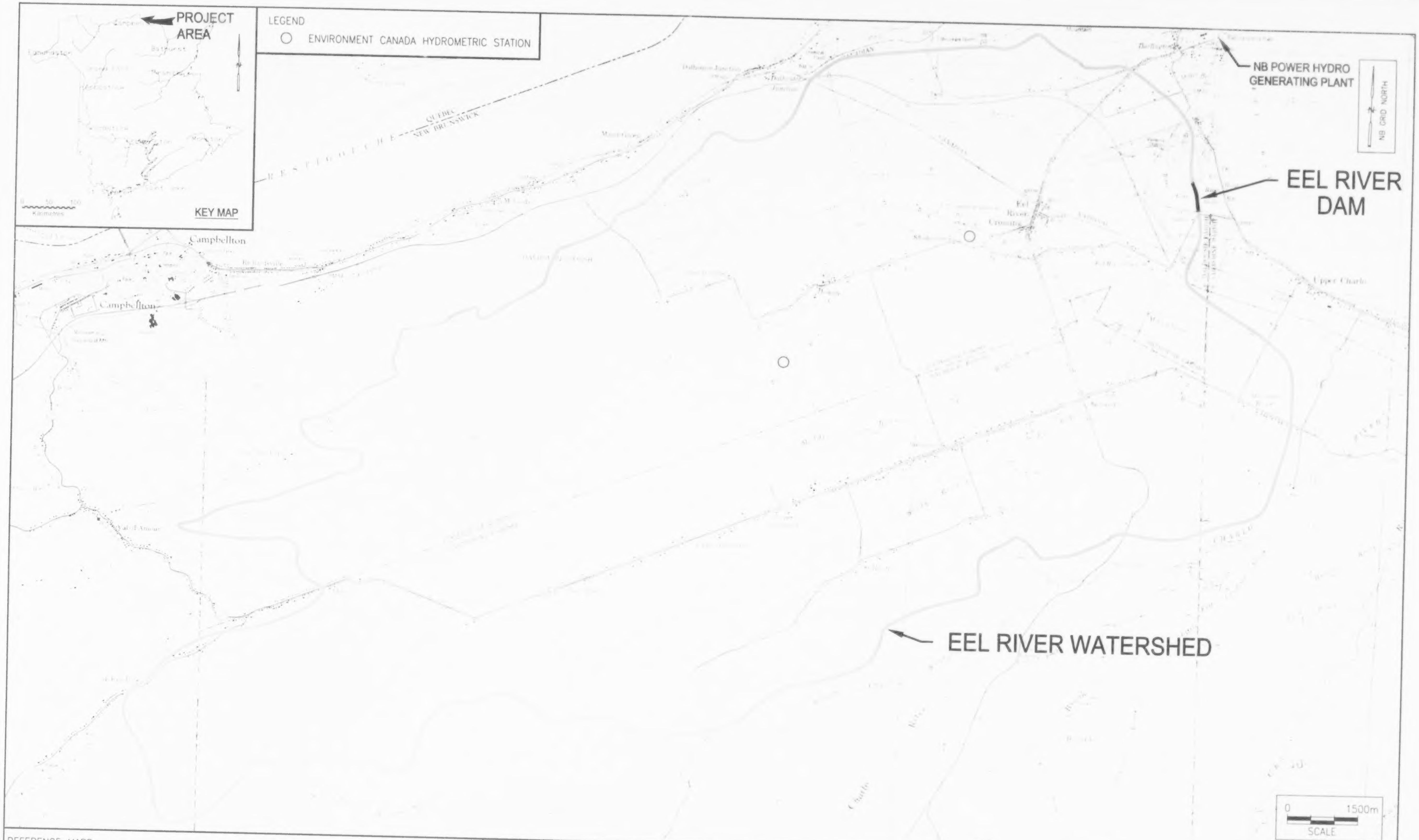
According to Eel River Bar First Nation, Fisheries and Oceans Canada (DFO), and the observation of others, Atlantic salmon were once plentiful in Eel River. Monitoring conducted by DFO and the New Brunswick Department of Natural Resources (NBDNR) in recent years has documented few adult salmon above the dam even though upstream spawning habitat is still suitable. Other diadromous fish have also experienced similar declines in Eel River, particularly rainbow smelt which may have become extirpated as a result of the dam.

While other factors may be contributing to the decline in global Atlantic salmon populations, the results of monitoring by DFO and NBDNR in Eel River clearly demonstrate that fish passage at the location of the dam is negatively affected for all diadromous fish species known to use the Eel River and estuary for life cycle purposes.

Sedimentation, such as that which has occurred since the construction of the dam, can destroy fish spawning and rearing habitat. Excess sediment can smother aquatic insects and their habitats and suffocate fish eggs and young fry (BMA and CG&S, 2000).

Construction of the dam resulted in the lake-like, freshwater impoundment, effectively destroying the estuarine habitat upstream of the dam, and harmfully altering the estuarine habitat below the dam.

Reports from DFO (Medcof, 1967) and observations by area residents, including the Eel River Bar First Nation (BMA and CG&S, 2000), clearly demonstrate that clam populations declined in the remaining estuary following dam construction. Clam populations that were located upstream of the dam were destroyed by the freshwater conditions. Increased sedimentation associated with the reduced tidal flushing has also been shown to occur and which contributed to substantial destruction of clam beds downstream of the dam (Medcof, 1967). Finally, the presence of sewage-related bacteria, made worse by the reduced tidal exchange, has resulted in closures of the remaining clam fishery in the Eel River estuary and Eel Bay.


PROJECT AREA
KEY MAP
LEGEND
○ ENVIRONMENT CANADA HYDROMETRIC STATION
NB POWER HYDRO GENERATING PLANT
NB GRID NORTH
EEL RIVER DAM
EEL RIVER WATERSHED
Campbellton
Eel River Crossing
RESTIGOUCHE
QUEBEC
NEW BRUNSWICK
0 1500m
SCALE

REFERENCE MAPS:
SURVEYS AND MAPPING BRANCH
DEPARTMENT OF ENERGY, MINES AND RESOURCES
OAK BAY 22 B/2, ESCUMINAC 22 B/1,
ATHOLVILLE 21-O/15, CHARLO 21-O/16

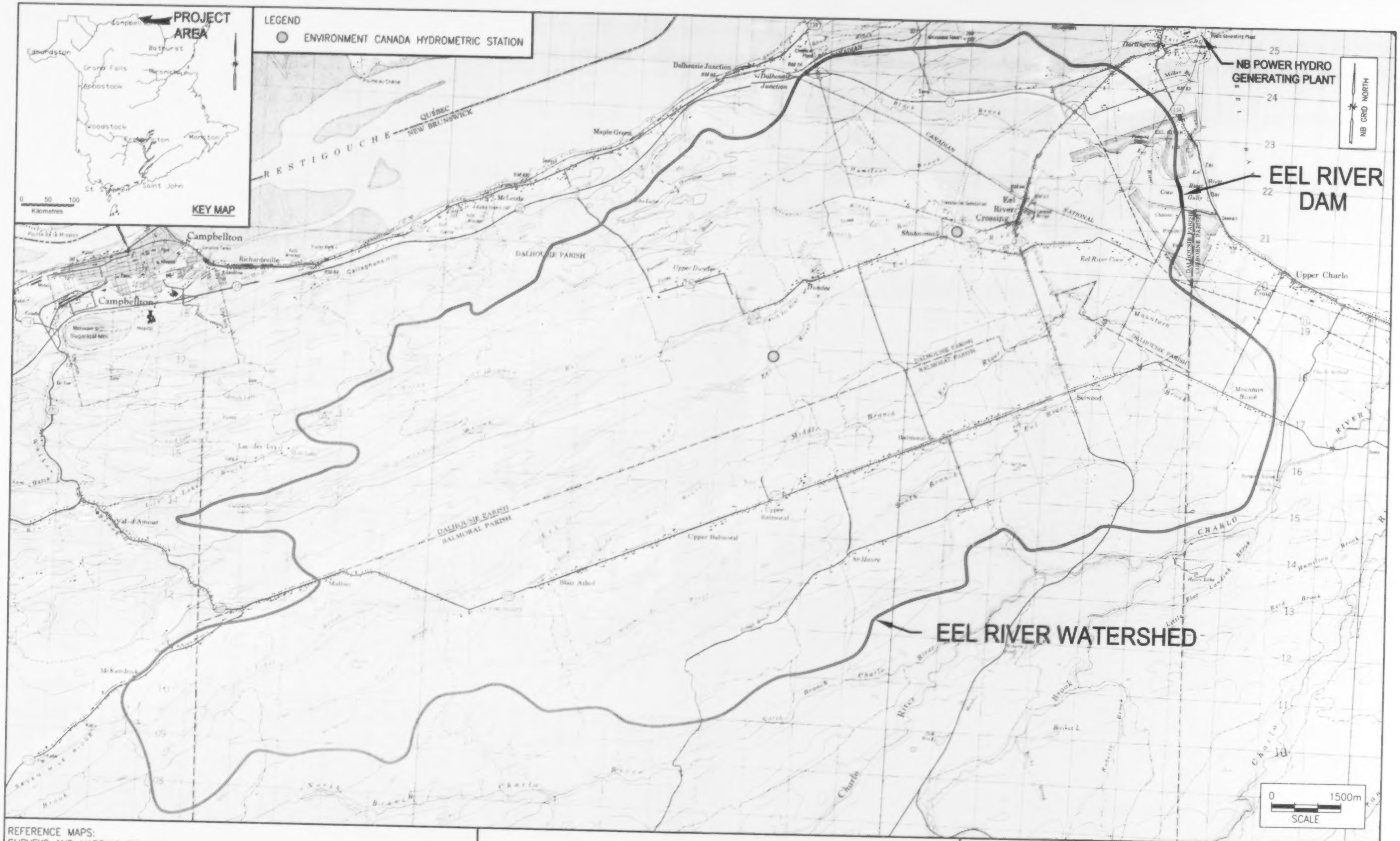
GENERAL SITE LOCATION
EEL RIVER DAM AND EEL RIVER WATERSHED

Date: 2006 03 31	Scale: 1 : 75 000
Job No: 15830	Fig. No.: 1.1.1

Eel River Dam

NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\SITE-LOCATION


PROJECT AREA
Campbellton
Edmundston
Bathurst
Grand Falls
Miramichi
Aroostook
Woodstock
Fredericton
Moncton
St. Stephen
Saint John
0 50 100
Kilometres
KEY MAP
LEGEND
○ ENVIRONMENT CANADA HYDROMETRIC STATION
NB POWER HYDRO GENERATING PLANT
NB GRID NORTH
EEL RIVER DAM
EEL RIVER WATERSHED
RESTIGOUCHE
QUÉBEC
NEW BRUNSWICK
Dalhousie Junction
Maple Green
McLeods
Campbellton
Richardsville
DALHOUSIE PARISH
BALMORAL PARISH
Upper Dundee
Dundee
Eel River Crossing
Eel River Cove
Upper Charlo
Selwood
Upper Balmoral
Blair Athol
Val-d'Amour
McKendrick
Lac des Lys
Eel River
Middle Branch
CHARLO
0 1500m
SCALE

REFERENCE MAPS:
SURVEYS AND MAPPING BRANCH
DEPARTMENT OF ENERGY, MINES AND RESOURCES
OAK BAY 22 B/2, ESCUMINAC 22 B/1,
ATHOLVILLE 21-0/15, CHARLO 21-0/16

GENERAL SITE LOCATION
EEL RIVER DAM AND EEL RIVER WATERSHED

Date: 2006 03 31
Scale: 1 : 75 000
Job No.: 15830
Fig. No.: 1.1.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\SITE-LOCATION

The rise in water level following dam construction covered the flood plain of the river, significantly altering the well-developed game bird habitat along riverbanks and surrounding the island that, prior to dam construction, was located approximately 2 km upstream of the dam (BMA and CG&S, 2000). The large expanse of salt marsh that bordered the flood plain prior to 1963 supported a community of emergent vegetation (plants growing mostly above or on water, with the root growth occurring mostly under water) that provided wildlife habitat and nutrient and contaminant removal functions. Currently only pocket wetlands and fringe wetlands remain along the shore of the impoundment. This has resulted in a loss of wetland area and a transition to less valued and lower functioning freshwater conditions.

1.1.3 Purpose of the Project

Since completion of the Eel River dam in 1964, various investigations of natural resources within the Eel River watershed (*i.e.*, river, estuary and bay) have concluded that deterioration of these resources is largely attributable to the presence of the dam.

The Eel River Bar First Nation receives financial compensation for losses of aquatic-based resources as a result of the dam, primarily related to fisheries (*e.g.*, clams, American eels, Atlantic salmon) and the harvesting of traditional plants.

An Agreement (dated December 10, 2002) was signed with the Province of New Brunswick, Her Majesty the Queen in Right of Canada (as represented by the Minister of INAC), and the Council of the Eel River Band, requiring that a comprehensive EIA be conducted for the proposed removal of the dam. That agreement expires in mid-2006 and the expectation of the First Nation is that the dam will be removed to restore lost estuarine conditions and provide opportunity for the re-establishment of lost aquatic resources and traditional uses of those resources.

The initially contemplated objective of the Project, as stated in the Final Guidelines for an Environmental Impact Assessment for the Removal of the Eel River Dam (the "EIA Guidelines"; Appendix A), was *achieving a long-term solution to fish passage and other ecosystem issues related to the presence of the dam (e.g., tidal exchange, sediment transport, wetland functions, populations of flora and fauna, fish habitat, etc.)*. This objective was defined in more detail and split into three parts during the development of the Final Terms of Reference for the Environmental Impact Assessment for the Removal of the Eel River Dam (the "EIA TOR") in consultation with federal and provincial regulatory representatives (see "Technical Review Committee" in Section 1.2.2). It is believed that achieving these "Project Objectives" will effectively satisfy the initial objective stated in the EIA Guidelines. The Project Objectives, as stated in the EIA TOR, are:

- a long-term solution to fish passage;
- establishment of conditions that lead to the natural re-establishment of saltmarsh wetlands upstream of the current dam location; and

- improvement of habitat for softshelled clams and other shellfish upstream and downstream of the dam.

The first of the three Project Objectives, hereafter referred to as the "fish passage Project Objective" was further defined in consultation with the Technical Review Committee as the "unimpeded and safe movement, upstream or downstream, of fish between aquatic habitats required to complete their life cycle". The fish species that are known to require passage through the dam for life cycle purposes are presented and discussed in Chapter 4.

1.2 Regulatory Context of EIA

The Project is subject to provincial and federal EIA/environmental assessment legislation. This Section describes the regulatory context for this EIA.

1.2.1 Proponent

The Proponent for the Project is the New Brunswick Department of Supply and Services (NBDSS), representing the Province of New Brunswick.

1.2.2 New Brunswick EIA Regulation

The Project was registered by NBDSS on March 28, 2003. On October 31, 2003, NBENV determined that the completion of a comprehensive EIA was required to assess the environmental effects of the Project under the New Brunswick *Environmental Impact Assessment Regulation (Regulation 87-83; EIA Regulation)* of the New Brunswick *Clean Environment Act*.

NBENV appointed a Technical Review Committee (TRC) comprised of technical specialists from various provincial and federal government agencies whose jurisdictions may be affected by the undertaking. The agencies represented on the TRC included:

- New Brunswick Department of the Environment and Local Government (NBDELG);
- New Brunswick Department of Natural Resources (NBDNR);
- New Brunswick Department of Health and Wellness (NBDHW);
- New Brunswick Department of Transportation (NBDOT);
- New Brunswick Culture & Sport Secretariat – Archaeological Services Unit (NBCSS);
- Restigouche District Planning Commission;
- New Brunswick Museum;
- Indian and Northern Affairs Canada (INAC);
- Transport Canada (TC)
- Environment Canada (EC);
- Fisheries and Oceans Canada (DFO);

- Health Canada; and
- Canadian Environmental Assessment Agency.

NBENV prepared the Draft EIA Guidelines that were reviewed by the TRC and provided to members of the Aboriginal Community, the public, and registered stakeholders for comment. Following public input, and a detailed review by the TRC, NBENV issued the Final EIA Guidelines on February 27, 2004. The EIA Guidelines outlined the requirements for the EIA and are available at the Project website (http://www.gnb.ca, keyword eel river dam).

Terms of reference outlining the approach proposed by NBDSS to meet the requirements of the EIA Guidelines were reviewed and accepted by the TRC. Final EIA TOR were issued on May 20, 2005.

1.2.3 Canadian Environmental Assessment Act

The Project also requires a screening level assessment under the *Canadian Environmental Assessment Act* (*CEAA*). The known requirement (at this time) is for authorization to access and use lands under subsection 28(2) of the *Indian Act*, a *CEAA* Law List Regulations trigger. Indian and Northern Affairs Canada (INAC) is the administrator of the *Indian Act*, and is therefore a Responsible Authority (RA).

The Project may also require authorization under the *Navigable Waters Protection Act* (*NWPA*), also a *CEAA* Law List Regulations trigger. Transport Canada is the administrator of the *NWPA* and would be an RA if it is determined that authorization is required under any of the following parts of the *NWPA*: paragraph 5(1)(a); subsection 6(4); section 16; or section 20.

Fisheries and Oceans Canada (DFO) has determined that the Project does not require authorization under any of the *CEAA* Law List Regulations pertaining to the *Fisheries Act*.

1.2.4 Purpose of EIA Report

The EIA Report is intended to fulfill the reporting requirements for a New Brunswick Comprehensive Review pursuant to the New Brunswick EIA Regulation and the EIA Guidelines. The EIA has also been conducted in consultation with likely federal Responsible Authorities under *CEAA*, and in this regard, the EIA Report is intended to support any future required *CEAA* environmental screenings assessments.

The purpose of the EIA Report is to present the results of the EIA study. The purpose of the EIA study was to evaluate and compare the potential environmental effects, including cumulative environmental effects, of the removal of the Eel River dam, evaluate the need for mitigation, determine significance of the residual environmental effects and compare these to the Status Quo, and consider the need for follow-up and monitoring. The Jacques Whitford Study Team, identified in Section 1.3, prepared this EIA Report on behalf of NBDSS.

1.3 Jacques Whitford Study Team

The Jacques Whitford Study Team and their roles and primary responsibilities are provided in Table 1.3.1.

Table 1.3.1 Jacques Whitford Study Team

Jacques Whitford Study Team Member	Role/Primary Responsibility
Jacques Whitford Limited	Project/EIA Management/Biophysical Studies
AMEC Earth and Environmental Limited	Biophysical Studies/Hydrodynamic, Sediment Transport, and Water Quality Modelling
ADI Limited	Socio-economic Studies
Gemtec Limited	Hydrodynamic Modelling/Biophysical Studies
Aboriginal Resource Consultants	Aboriginal Meetings

2.0 EIA METHODS AND SCOPE

2.1 Environmental Assessment Methods

This section provides the methodology carried out for the EIA. The methodology was designed to address the requirements of the EIA Guidelines. The methodology was initially presented in the EIA TOR; however, it was altered during the EIA in consideration of the evolving understanding of the nature of the Project. The EIA methodology involved the following phases:

- scoping;
- data collection;
- description of past and existing environments;
- evaluation of the existing fishway and potential improvements to the fishway against the Project objectives;
- development of the Project Description;
- description of the future anticipated environment; and
- environmental effects assessment.

The list of phases above presents the general order that each phase was initiated and the order as presented in this EIA Report, however, many of these phases were conducted simultaneously in parts with one another. For example, the public consultation portion of the scoping phase began with the initiation of the EIA, and will continue through to the end of the EIA process.

2.1.1 Scoping

Scoping refers to the process of defining and refining the scope of the Project and the scope of the EIA. This involved identifying issues and factors that were considered in the EIA and included the development of the EIA Guidelines, the EIA TOR, and the EIA methodology. Public consultation and meetings with the Aboriginal Community and key stakeholders were a major component of the scoping process. Valued Environmental Components (VECs) were selected as part of the scoping process to focus the environmental effects analysis. The results of the scoping process are presented in Section 2.2 (Public Consultation, Scoping and Selection of Valued Environmental Components).

2.1.2 Data Collection

Three separate investigations were carried out to address data collection needs in support of the EIA. These investigations are:

- the biophysical investigation;
- the socio-economic investigation; and
- the hydrodynamic, water quality and geomorphological investigation.

A summary of each investigation is provided in this section.

2.1.2.1 Biophysical Investigation

The biophysical investigation encompasses relevant aspects of the aquatic, atmospheric and terrestrial environment, including wetlands. Information obtained as part of this investigation includes:

- atmospheric environment – weather and climate and ambient air quality;
- fish and fish habitat – species composition and relative abundance through fyke netting and minnow traps (other methods had shortcomings because of excessive aquatic vegetation in the impoundment);
- benthic invertebrates – distribution and abundance of mussels and clams in shellfish beds;
- water quality – seasonal water profiles, temperature and levels of nutrients, dissolved oxygen, salinity, total suspended sediments, total organic carbon and trace metals;
- sediment quality – physico-chemical characterization and distribution of sediment quality, organic analytes, including total poly-chlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs), and metals; and
- terrestrial and wetland habitat – migrating and resident bird surveys, wetland classification, plant inventory, wildlife observations and AC CDC database results.

The biophysical data collection process began by determining what data was required to support the preparation of the EIA Report and meet the requirements of the EIA Guidelines and the Terms of Reference. Once data requirements were determined, the next step was to review existing data and identify "data gaps", or non-existing data that were determined to be necessary for the EIA. Field surveys and expert consultations were conducted to gather data. During this time, additional information and/or concerns raised during the public consultation process (including meetings with the Aboriginal Community, stakeholders, and the TRC) were considered and the need for additional data collection was evaluated and carried out where appropriate (*e.g.*, summer water temperature data for the impoundment). The data were processed and are presented in Chapter 3.

The results of the biophysical investigation were separated into the pre-dam (prior to 1963) and the post-dam and existing (1963-2005) conditions. Information within this format was arranged by the VECs selected in Section 2.2.3. Pre-dam conditions are described based on available data and are limited to that which is known for past or historical conditions.

2.1.2.2 Socio-economic Investigation

The socio-economic investigation includes information obtained through field sampling, public open houses, and meetings with the Aboriginal Community, municipal, industrial and other registered stakeholders. Information obtained as part of this investigation includes (organized by environmental component):

- municipal services and infrastructure – water supply and distribution systems, sanitary and storm sewer systems, dams and wharves;
- transportation network – highway network, level of service and flood prone and storm damage highway sections;
- vessel navigation – commercial marine traffic and recreational boating;
- tourism – important provincial attractions, tourism indicators, tourism trends and opportunities, Eel River tourism attractions and tourism above the dam;
- recreation – sport fishing, recreational boating and fishing, bird watching, walking and hiking trails;
- labour and economy – regional employment, population, income, labour force, fisheries, agriculture, tourism;
- heritage and archaeological resources – Pre-contact period, Eel River Bar First Nation, Acadian settlement, other European settlement, historic structures and shipwrecks; and
- public health and safety – flooding, bacteriological environment and human food resources and quality (contaminants).

The socio-economic investigation data collection process was identical to that of the biophysical investigation described above. The results were also presented in the same format as the biophysical investigation.

2.1.2.3 Hydrodynamic, Water Quality and Geomorphological Investigation

The hydrodynamic, water quality and geomorphological investigations (Appendix B) included specific information on the following:

- channel morphology – depth soundings, sediment type and total water volume at several cross sections in the Assessment Area;
- tidal regime – maximum and minimum tidal envelopes;
- flooding – maximum water levels, extreme hydrologic events;
- water quality – contaminant sources, loading rates and concentrations;
- geomorphology – sediment transport, erosion and shorelines; and
- ice regime.

Hydrodynamic modelling of Eel River extended from the CN Railway bridge in the Village of Eel River Crossing to the tidal inlet of the estuary. The models were calibrated and verified using the data collected specifically for this investigation, and from the biophysical investigation. The results of the models were used as a tool, in combination with the trend analysis, interviews and the expertise and knowledge of the Jacques Whitford Study Team, to identify anticipated changes to Eel River resulting from the Project.

As appropriate, reference to this investigation in Appendix B is provided for data or information presented in Chapter 3 of the EIA Report to assist the reader in locating more detailed or source information if desired.

2.1.3 Description of Pre-dam and Post-dam Environments

Chapter 3 presents a summary of the data and information that were collected to describe the pre-dam and post-dam (including present) conditions for each VEC. Chapter 3 provides an overview of the key information necessary to support the environmental effects assessment of the Project.

2.1.4 Evaluation of the Existing Fishway and Potential Improvements to the Fishway Against the Project Objectives

Chapter 4 presents the evaluation of the existing fishway and improvements to the fishway that could be made to improve its performance, against the Project Objectives. Potential improvements to the fishway were considered as potential alternatives to the Project, as defined under *CEAA*.

2.1.5 Development of the Project Description

The Project Description is presented in Chapter 5 of this EIA Report. The Project Description outlines the decommissioning work that is proposed to satisfy the Project Objectives as defined in the TOR. The Project Description includes mitigation to minimize potential environmental effects of the Project. Potential accidents, malfunctions and unplanned events of the Project were considered in developing the Project Description and a description of these is provided in Chapter 5, as is an outline of the proposed Environmental Management Plan. Alternative means of carrying out the Project, as defined under *CEAA*, were also considered during the development of the Project Description.

2.1.6 Description of the Future Anticipated Environment

Computer modelling was carried out to provide a broad understanding of the hydrodynamic conditions, including water quality and ice regime, that would occur in the Eel River estuary with the dam removed. A summary of the results of the modelling is presented in Chapter 6. A detailed description of the modelling, including assumptions, calibrations, inputs and results, is provided in Appendix B.

In addition to the computer modelling, other predictive tools such as trend analysis and the professional judgment (*i.e.*, judgments based on professional knowledge and experience) of the Jacques Whitford Study Team were used to predict the future estuarine environment.

2.1.7 Environmental Effects Assessment

2.1.7.1 Environmental Assessment Boundaries

For each VEC, assessment boundaries are described in time and space. The temporal boundaries of the study (the length of time over which project environmental effects (positive and negative) are anticipated to occur) reflect the decommissioning period, and extent of any potentially significant environmental effects (positive and negative) that may remain beyond the decommissioning period, including any potential accidents, malfunctions or unplanned events.

Spatial boundaries reflect the geographical extent to which activities associated with the Project are anticipated to occur in the existing environment and the extent of existing or anticipated positive and negative environmental effects, including cumulative environmental effects, for each VEC. Spatial boundaries are referred to as the "Assessment Area" and are defined for each VEC within the relevant sections of Chapter 7 and included in a summary table in Section 2.2.3. Administrative and technical boundaries of the assessment are also defined, where appropriate.

2.1.7.2 Criteria for the Determination of Significance

For each VEC, the thresholds of environmental effects that would be considered significant for decision-making purposes under the NB *EIA Regulation* and *CEAA* are defined in the relevant VEC sub-sections of Chapter 7.

2.1.7.3 Environmental Effects Analysis

The environmental effects analysis is organized by VEC in Chapter 7. Potential environmental effects were analyzed for each VEC by evaluating how the VEC will be affected by the Project. The EIA employed a comparative environmental assessment methodology that also considered what the potential environmental effects of the Status Quo would be. As the Status Quo would not meet the Project Objectives, the analysis of the Status Quo was performed for comparative purposes only, and consequently mitigation was not developed for potentially significant environmental effects that would result from the Status Quo.

2.1.7.4 Accidents, Malfunctions and Unplanned Events

A discussion of potential accidents, malfunctions and unplanned events for the Status Quo and for the Project is provided for each VEC within the relevant sections of Chapter 7. Mitigation and Project planning strategies that will minimize the potential for accidents, malfunctions and unplanned events are also described for each VEC.

2.1.7.5 Effects of the Environment on the Project

Key effects of the environment on the Project and Status Quo were assessed in Chapter 8. These included: erosion and deposition; tidal prism; weather; flooding; ice; climate change; and earthquake activity.

2.1.7.6 Cumulative Environmental Effects

Regional cumulative environmental effects issues of concern that are affected by the Status Quo or Project are identified in Chapter 9. Other projects that have environmental effects that overlap with those of the Status Quo and Project are also identified. The cumulative environmental effects of the Project, in combination with those of other projects were evaluated, and compared to those of the Status Quo where appropriate. The significance of cumulative environmental effects was considered, and mitigation that will be applied to minimize or manage cumulative environmental effects is proposed.

2.1.7.7 Follow-up Program

As part of the environmental effects analysis for each VEC, follow-up and monitoring are described for each VEC where appropriate or warranted in Chapter 10.

2.1.7.8 Summary and Conclusions

Chapter 11 provides a summary of the findings of the EIA Report and conclusions as to the relative environmental effects of maintaining the Status Quo and implementing the Project.

2.2 Public Consultation, Scoping and Selection of Valued Environmental Components

Public, stakeholder, regulatory and Aboriginal consultation were essential components of the EIA. The consultation program for this EIA was designed to meet the requirements of the EIA Regulation and *CEAA* as outlined in the Guidelines, and to ensure that the general public, regulators, stakeholders and the Aboriginal Community were able to identify issues and concerns related to the proposed Project that should be considered in the EIA study.

The results of this consultation and meeting process were considered during the EIA and are presented in the following sections.

2.2.1 Public, Regulatory, and Stakeholder Consultation, and Meetings with the Aboriginal Community

2.2.1.1 Regulatory Consultation

The Jacques Whitford Study Team and NBDSS worked closely with the TRC to ensure that the EIA was conducted in accordance with the Guidelines and the TOR. Discussions with the TRC continued throughout the EIA process and meetings were held on a regular basis to provide updates on the EIA and to seek feedback. As discussed in Section 2.1.2.1, a draft summary of the pre-dam and post-dam data that was available as of March 2005 was provided to the TRC for consideration in developing the scope of the Summer 2005 field investigation.

2.2.1.2 Public Consultation

The primary form of public consultation was the "Open House" format. Two rounds of open houses were planned, one round on December 7 and 8, 2004 and the second round on November 8 and 9, 2005. The December 7, 2004 open house occurred in Eel River bar where approximately 60 community members, including Elders, Chief and representatives of the Council of ERBFN, concerned citizens and stakeholders, participated. The December 8, 2004 open house took place in the Town of Dalhousie. There were only 10 visitors to the Dalhousie open house. A snowstorm in the previous 24 hours may have limited the number of attendees due to resultant and persisting poor road conditions. The fall 2005 Open Houses occurred at ERBFN on November 8, 2005, attended by 18 people, and in the Village of Eel River Crossing on November 9, 2005, attended by 26 people.

The issues, concerns and comments from attendees at the first and second rounds of open houses are summarized in Table 2.2.1.

Table 2.2.1 Summary of Issues, Concerns and Comments from Open Houses, December 7 and 8, 2004 and November 8 and 9, 2005

Open House in Eel River Bar (Community Hall) – December 7, 2004
• Presentation did not address negative impacts of the dam.
• Were sludge samples analyzed for contaminants?
• Are the fish sampled normal since there are a lot of chemicals in the river?
• How long will the Decommissioning take?
• Will all of the sludge in the impoundment be taken away?
• When will the clams come back?
• Are fish being dissected to check for chemicals?
• If the fish are released into the ocean, will they affect ocean species that eat them?
• Economic base of Eel River bar was destroyed when the dam was constructed. Community will not support an EIA Report that does not recommend full dismantling of Eel River dam.
• Will EIA Report look at surrounding industry to determine if contaminants are still going into Eel River?
• Who is responsible for clean up of sewage that is now dumped into Eel River?
• Want to get access to reports and data. Question whether they will be accurate or geared to aid industry.
• Prior to Eel River dam construction, there were lots of fish. After dam constructed, smelt and clam fisheries were destroyed.
• Community has lost property due to encroaching water. Land has eroded up to houses and roads.
• Full removal of Eel River dam will allow the area to be used for tourism again.
• Will removal of Eel River dam affect plant Species at Risk? Will it affect decision on full removal of dam? If it's plants, bugs or us – they have to go. Nature will reclaim the area.
• Would like to see complete dismantling of Eel River dam.
• Who will compensate for the Decommissioning when we have not even been compensated for the dam's construction and loss of resources?
• What role does Town of Dalhousie have in the decision making process?
• Land has been lost as a result of the Eel River dam.
• Will data and reports be released to Environment Canada?
• Where there used to be salmon and trout, there are now more perch and suckers.
• Partial removal of Eel River dam (only structure and not land bridge) will not work because it will cause a bottleneck, creating more fishing problems.
• Were salmon collected during sampling? Salmon were collected during DFO fish assessment 11 years ago.

Table 2.2.1 Summary of Issues, Concerns and Comments from Open Houses, December 7 and 8, 2004 and November 8 and 9, 2005

Open House in Town of Dalhousie (Dalhousie Recreaplex Centre) – December 8, 2004

- Concern over long-term impacts on the environment.
- Concern over long-term impact on fish.
- This is just the beginning. There is not enough information on property owners along the river and estuary.
- Take into consideration the ecosystem of Chaleur Bay.
- Are the high costs for this study and the total or partial removal of the dam necessary? If so, for whom?
- The salmon that will access the river cannot be adequately protected and will be vulnerable to poaching.
- Industrial NB Power is a major user of the Eel River water supply.

Open House in Eel River Bar (Community Hall) – November 8, 2005

- What is the size of the fishway?
- Did the Eel River bar exist before Highway 134 was constructed?
- When we are talking about dam removal do we mean the whole dam or just the gates?
- If a staged removal were decided upon, which side of the dam would be removed first?
- How will the study address how sediments will be removed if the dam is removed or will we simply let nature take its course?
- Will the study address the sediments both above and below the dam?
- Are there any pre-dam studies available online to review?
- Was water and sediment testing conducted in 2005 as they had been done in 2004?
- If the Study indicates that contaminants are not a problem in the water then why were there shellfish closures in the area?
- Were other comparison studies conducted to compare other nearby watersheds with this one with respect to the metals levels in the area?
- We would like to see the Black Brook looked at to see if the dumpsite is impacting water quality.
- Are the sediments in the estuary conducive to clam production?
- Is it known what plant species were lost or changed because of the dam?
- Will we know the number of salmon returning?
- Was the coliform in the water or just in the clams?
- If the dam is decommissioned has a source of water for NB Power been identified?

Table 2.2.1 **Summary of Issues, Concerns and Comments from Open Houses, December 7 and 8, 2004 and November 8 and 9, 2005**

Open House in Eel River Crossing – November 9, 2005
• Before the dam was constructed, we used to fish upstream of the dam; however, today there is less water upstream of the dam and less fish.
• How high will the water level be at Eel River Crossing if Eel River dam is removed?
• Will the dam be removed all at once?
• What is the schedule for dam removal?
• What will happen to the freshwater vegetation/plants and wildlife species if the dam is removed *e.g.*, fish, beavers, muskrats, birds, etc.?
• When will government make a decision?
• How much will the dam removal cost?
• Will the provincial and federal governments be responsible for the project funding if the dam is removed?
• What is the difference between the Public Information Session and the Public Hearing/Meeting organized by the Department of Environment?
• What is the role of the Technical Review Committee?
• When is the next public information session for this project?
• Will an alternate freshwater source be located for NB Power Dalhousie Generating Plant if the dam is removed?
• Will the new Aboriginal Gardens site be impacted if the Eel River dam is removed? (*e.g.*, erosion of river banks, loss of freshwater body for fire protection and watering plants).
• Why was the water level so low in the Eel River impoundment this summer?
• Will a copy of the open house presentation be made available to registered stakeholders and posted on the website?
• How will the riverbanks be protected from erosion if Eel River dam is removed?
• What were the results of the water, soil, fish and clam testing? Will the results be posted on the project website?
• Will Eel River be restored to pre-dam conditions if the dam is removed?
• The modelling poster time unit indicated at the bottom should note time in hours.
• Will there be more mosquitoes if the dam is removed?
• Will the silt and debris build up in the Eel River impoundment be removed or dredged if the dam is removed?

Communication with the public also used various tools such as media outlets, an Issues Tracking Log, an EIA study website and a toll-free number. The EIA study website was maintained and updated by NBDSS. The website was an interactive bilingual site providing key EIA documents, updates on the progress of the study including field programs, a public consultation link that includes up to date issues, tracking log, summary of open houses and presentations and consultation activities. Links to other government websites including the Petitcodiac River causeway EIA study website, frequently asked questions section, glossary and tide table and photographs related to the EIA study were also included. The website experienced 60,330 hits in 2005. The average number of hits per month was 5,027. The peak number of hits per month was 7,077 in March, and the lowest number of hits per month was 3,188 in December 2005. In general, interest in the website appears to have been greatest from January to May 2005 when the average number of hits per month was almost 6,500.

A toll free number, 1-888-804-5566, was in operation throughout the EIA process. This number provided the public with access to the consultant Study Manager allowing them to identify issues or concerns, or to obtain information on the EIA study.

2.2.1.3 Stakeholder Consultation

Stakeholders were registered by NBDSS as intervenors in the process. This involved a notice placed in the media requesting that stakeholders apply to NBDSS for formal intervenor status. This procedure identified groups that wished to respond to information presented in the EIA Report, and to participate effectively in the consultation and communication process. Following is the list of declared stakeholders identified through this process:

- Village of Balmoral;
- Village of Charlo;
- Village of Eel River Crossing;
- Town of Dalhousie;
- Bowater Maritimes Inc.;
- Eel River Bar First Nation;
- NB Power Corporation;
- New Brunswick Trails Council Inc.;
- Restigouche Naturalists Club;
- Petitcodiac Riverkeeper;
- Charlo Sentiers NB Trails Inc.;
- RPM Design & Construction Ltd.; and
- Cocagne Watershed Sustainable Development Group.

Issues and concerns raised during the meetings with various registered stakeholders are summarized in Table 2.2.2.

Table 2.2.2 Issues/Concerns Raised During Stakeholder Meetings

Meeting Date	Issues/Concerns Raised
Village of Eel River Crossing (December 9, 2004)	• Concerned about the impact of tidal saltwater on existing freshwater wells and flooding if Eel River dam is removed. • Concerned about sewage outfalls from other communities that are connected to Eel River. • Concerned about what will happen to Crown land adjacent to the impoundment and river if Eel River dam is removed. Will the land be sold? • If Eel River dam is removed, will former owners of property along the estuary have first right to re-purchase from Crown? • Village is currently looking at alternative freshwater sources and there is concern that there may be limited sites for drilling wells if Eel River dam is removed.

Table 2.2.2 Issues/Concerns Raised During Stakeholder Meetings

Meeting Date	Issues/Concerns Raised
Town of Dalhousie (December 9, 2004)	• Concern over loss of freshwater habitat and increase in Total Suspended Sediments. • NB Power requires alternate water source for generating plant. • Loss of water in Eel River impoundment may create contamination and odour problems. • Who will finance Eel River dam removal and remediation? • Concern about poaching of salmon upstream of Eel River dam. • Can the existing fish ladder be modified to enhance fish passage so that Eel River dam does not have to be removed? • Would like EIA Report to address tourism and economic development impact with a free-flowing river versus an impoundment. • Concern that removal of Eel River dam will cause restriction in future development in area due to lack of water.
Village of Charlo (December 8, 2004)	• Concerned with impact of pollution issues on tourism if Eel River dam is removed, including Charlo campground, public swimming beach, kayaking on Bay, Heron's Nest Cottages and Aboriginal Heritage Garden. • Would like EIA Report to investigate potential contamination if Eel River dam was removed since Village of Eel River Crossing Sewage Lagoon outfall has been deposited into the Eel River impoundment for a number of years.
Bowater Maritimes Inc. (December 8, 2004)	• Positive impact of Eel River dam removal would be elimination of need to pump water from impoundment in winter due to pipeline freezing. • Suggest replacing water source for fire protection for Dalhousie Community Health Centre and East Wharf warehouse by connecting to Town of Dalhousie water supply or Bowater water supply for the mill. • If impoundment is contaminated would the EIA Report recommend dredging to remove contaminants?
Village of Balmoral (December 7, 2004)	• If Eel River dam is removed there will be less water in Eel River which may affect sewage lagoon. • Concerned with swampy land, bottom impoundment contamination and odour problems if Eel River dam is removed. • Would like EIA Report to address other tributaries entering Eel River and effects on tourism in Eel River watershed if Eel River dam is removed.
NB Power (November 19, 2004)	• Concerned about loss of water supply should Eel River dam be removed. • Asked if EIA Report would identify alternate water sources for NB Power. Would area water supplies be documented? • Would like EIA Report to address negative impacts of removing Eel River dam including erosion, freshwater wetlands and trapping in impoundment.

2.2.1.4 Aboriginal Community Meetings

Meetings with the ERBFN provided opportunities for meaningful discussion and input into the decision-making process. Aboriginal Community meetings were initiated through discussions with ERBFN at a meeting on November 16, 2004 (see Table 2.2.3 for a summary of issues raised). A summary of issues raised at the first and second rounds of open houses, one held at the Community Hall in Eel River bar on December 7, 2004, and the other held at the same venue on November 8, 2005 are located in Table 2.2.1. Meetings on March 10, 2005 and August 2, 2005 are summarized in Table 2.2.3. Correspondence was also received from ERBFN, indicating support for removal of the Eel River dam. Issues raised by ERBFN included the economic loss experienced by Eel River bar due to closure of the clam fishery as a result of the dam and the contribution of the dam to flooding, shoreline erosion and alterations, large sand and gravel deposits, and a higher water table.

Table 2.2.3 Issues/Concerns Raised During ERBFN Meetings

Eel River Bar First Nation (November 16, 2004)	• Would like EIA Report to investigate sewage/effluent disposal into Eel River impoundment from the Village of Balmoral, Dundee (Unincorporated) and some residential houses in Eel River Crossing. • Would like EIA Report to address sediment deposition on each side of Eel River dam, including sediment quality, chemistry and potential contamination. • How will the amount and location of shoreline erosion as a result of removal of Eel River dam be determined? • Will the Aboriginal Heritage Garden development be affected by removal of Eel River dam? • How long will it take for Eel River to be restored to original state after dam is removed? • Note that impoundment area is now a productive beaver and muskrat trapping area – trappers claim it is one of the finest trapping areas in New Brunswick. • Alternate routing of the New Brunswick Trail system will be required if Eel River dam is completely removed. • Would like to see EIA Report address potential tourism and recreation effects of Project.
Eel River Bar First Nation (March 10, 2005)	• Concerned with sewage entering stream from Dundee (Unincorporated) and the Village of Balmoral and its impact in the fishery. • Concerned about silt build up since the dam was constructed. The dam construction impacted tidal action and increased silt build up. • ERBFN would like to see the clam fishery, bird and fish population increased and the sweet grass return once the dam is removed.
Eel River Bar First Nation (August 2, 2005)	• Ducks have decreased since dam construction as the dam acts as a barrier. • A suggestion was made that Popelogan Lake may be a source of water for NB Power. • Inquired about the life span of the Dalhousie Generating Station.

2.2.1.5 Summary

The Environmental Effects Assessment Chapter (Chapter 7) addresses many of the issues and concerns that came out of the consultations and meetings.

2.2.2 Scope of the Project and the Assessment

2.2.2.1 Scope of the Project

The scope of the Project to be assessed pursuant to Section 15(1) of the New Brunswick *EIA Regulation*, and as described in the EIA Guidelines, includes a complete description of the Project from planning through Decommissioning of the dam, including any post-Decommissioning activities. Specifically, the scope of the Project to be assessed includes the following Project-related components and activities:

- proposed method for removal of the dam and associated infrastructure;
- transportation, handling and storage of hazardous materials required for Decommissioning;
- transportation, handling and storage of wastes and by-products from Decommissioning; and
- secondary containment systems (if applicable).

2.2.2.2 Scope of the Assessment

The scope of the assessment included the factors to be considered pursuant to both Section 16(1) of *CEAA* and additional requirements under the NB *EIA Regulation* as specified in the EIA Guidelines and elaborated in the EIA TOR. The EIA Report provides a detailed study of potential positive and negative environmental effects, the significance of the environmental effects, and identifies the proposed monitoring and follow-up programs. Decommissioning includes the removal of the Eel River dam, including the earthen dyke, concrete water control structure, and associated infrastructure (*e.g.*, fish passage facilities).

The factors to be considered in the scope of the assessment are:

- history of environmental concerns with the Eel River dam, and applicable general information on the construction and operation of tidal barriers;
- the environmental effects that have occurred over time due to construction and presence of the dam;
- the existing environment;
- potential alternatives to the Project;
- potential alternative means of carrying out the Project that are technically and economically feasible and the environmental effects of any such alternative means;
- environmental effects, including effects of accidents and malfunctions, and cumulative environmental effects of the Project;
- mitigation measures that are technically and economically feasible;
- health and safety and environmental protection measures, including contingency plans;
- comments from the public;
- the need for, and the requirements of, any monitoring and/or follow-up programs; and
- the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future.

2.2.3 Selection of Valued Environmental Components

The selection of VECs was based on the public consultation process outlined in Section 2.2, the Guidelines, the EIA TOR, and the professional judgment of the Jacques Whitford Study Team. The final list of VECs was developed to address both biophysical and socio-economic aspects of the environment. The rationale for the selection of each VEC is provided in Chapter 7. It should be noted that Infrastructure was not included as a separate VEC (as presented in the EIA TOR) due to inclusion of relevant aspects of infrastructure in other related VECs. For example, the water supply infrastructure of NB Power is addressed within the Water Resources VEC, roads and bridges are addressed within the Transportation Network VEC, and the unofficially recognized trail (by the provincial NB Trails or municipally) that crosses the dam is addressed in the Tourism and Recreation VEC.

The temporal boundaries for the assessment of all VECs include the Decommissioning period out to approximately 10 years after removal of the dam is complete. These boundaries are set based on the results of the modelling performed for this EIA. Ten years is the estimated time required for the estuarine system (hydrodynamics and geomorphology) to reach a new steady-state equilibrium.

Table 2.2.4 Valued Environmental Components

Valued Environmental Component	Key Aspect	Issues and Factors to be Considered	VEC Spatial Boundaries (the "Assessment Area")
Atmospheric Environment	Climate	• Microclimate conditions, including fog and temperature.	Air Quality, Sound Quality, Odour – The Eel River impoundment and nearby communities of Eel River Crossing, Eel River Bar First Nation (ERBFN), Charlo, Balmoral and Dalhousie, and the surrounding neighbouring communities of the northern Restigouche County coastline. Climate – Northern New Brunswick, including the Counties of Restigouche and Gloucester.
	Air Quality	• Emissions of conventional air contaminants from decommissioning activities, including dust.	
	Sound Quality	• Noise from decommissioning activities, including trucking of material for disposal.	
	Odour	• Odour from exposure of mudflats and decaying wetland vegetation.	
Fish Habitat and Fish	Water Quality	• Water chemistry, including nutrients. • Suspended sediments. • Mixing zone of fresh and saltwater.	The waters upstream and downstream of the Eel River dam that may be affected by the Project, from the dam to the upper end of the impoundment and from the dam to the marine environment close to the tidal inlet in Eel Bay.
	Sediment Quality	• Sediment chemistry. • Physical properties.	
	Fish	• Freshwater, marine and diadromous species presence. • Direct mortality. • Change in habitat. • Fish migration impediments.	
Terrestrial Environment	Wetlands and Riparian Vegetation	• Wetland quality. • Wetland quantity. • Riparian vegetation species of conservation concern.	The wetland and riparian environments upstream and downstream of Eel River dam that may be affected by removal of the dam, specifically from the dam to the upper end of the impoundment and from the dam to the Eel River bar.
	Wildlife	• Species of Conservation Concern. • Quantity and quality of habitat.	
Migratory Birds	Migratory Birds	• Migratory bird habitat.	The environment upstream and downstream of Eel River dam that may be affected by removal of the dam, specifically from the dam to the upper end of the impoundment and from the dam to the Eel River estuary and the adjacent marine zone bounded by Eel Bay.
Species At Risk	Fish Wildlife Birds Vegetation	• Federal *Species at Risk Act*. • Provincial *Endangered Species Act*. • Direct mortality. • Change in habitat.	The aquatic, wetland and riparian environments upstream and downstream of Eel River dam that may be affected by removal of the dam, specifically from the dam to the upper end of the impoundment and from the dam to the Eel River bar
Water Resources	Groundwater	• Groundwater use and availability.	The Eel River estuary from the Village of Eel River Crossing to the mouth of Eel Bay and underlying groundwater, and other water resources that may be used by current users of the Eel River impoundment.
	Surface water	• Surface water use and availability. • Surface water use infrastructure.	

Table 2.2.4 Valued Environmental Components

Valued Environmental Component	Key Aspect	Issues and Factors to be Considered	VEC Spatial Boundaries (the "Assessment Area")
Vessel Navigation	Vessel Navigation	• Navigational opportunities. • Vessel traffic.	The waters upstream and downstream of Eel River dam that may be affected by the Project, from the dam to the upper end of the impoundment and from the dam to the marine environment close to the tidal inlet in Eel Bay.
Transportation Network	Transportation Network	• Traffic activity. • Level of Service. • Road infrastructure.	Highway 11 (from Route 275 to Route 230); Route 134 (from Dalhousie to Charlo); Route 275 (from Highway 11 to Route 280); and Route 280 (from Route 275 to Route 134), and the CN Rail line.
Current Use of Lands and Resources for Traditional Purposes	Current Aboriginal Land and Resource Use	• Identified current uses of land and resources for traditional purposes by Aboriginal Persons.	The Eel River watershed with focus on both the watercourse itself and also the adjacent shorelines.
Tourism and Recreation	Tourism	• Tourism opportunity.	The Villages of Charlo, Eel River Crossing, Balmoral and the ERBFN, as well as portions of the parishes (Local Service District) of Balmoral and Dalhousie including the Town of Dalhousie.
	Recreation	• Recreational opportunity. • NB Trails.	
Labour and Economy	Commercial Fisheries	• Clams • Fish	The Villages of Charlo, Eel River Crossing, Balmoral and the ERBFN, as well as portions of the parishes (Local Service District) of Balmoral and Dalhousie including the Town of Dalhousie.
Heritage and Archaeological Resources	Heritage and Archaeological Resources	• Loss of heritage and archaeological resources.	The Eel River dam and adjacent shorelines, as well as the locations where there are likely to be environmental effects to lands that may contain heritage or archaeological resources, such as any ground disturbance or increased erosion of riverbanks in the impoundment area and Eel River estuary downstream, as well as portions of the river that have been flooded as a result of the construction of the dam.
Public Health and Safety	Water Resources	• Bacterial or heavy metal contamination of water used for recreation or consumption.	The dam to the Village of Eel River Crossing and from the dam to the Eel River bar and beyond in Eel Bay.
	Infrastructure Damage	• Flooding • Tidal surge	
	Human Food Resources	• Bacterial contamination (from sewage) or heavy metal contamination of recreational and commercial harvested fish, including clams.	

3.0 DESCRIPTION OF THE ENVIRONMENT

3.1 Coastal and Oceanographic Overview

3.1.1 Pre-dam Conditions

No information could be found on the oceanographic conditions prior to the construction of the Eel River dam in 1963.

The sand bar (Eel River bar) at the mouth of the Eel River estuary existed prior to the construction of the Eel River dam. A bar of sand and gravel approximately 1,500 m in length extended across most of the lower portion of the Eel River estuary and a characteristic narrow tidal inlet existed at the north end of the bar. The maximum width of the estuary, at the current location of the dam, was about 600 m, which is not much different from post-dam conditions. The length of the estuary, however, was much longer and was approximately 6,100 m, compared to 1,430 m under present conditions. Prior to the construction of the dam, the estuary extended from the head of tide approximately where the Canadian National Railway Bridge is located in the Village of Eel River Crossing to the mouth at the tidal inlet. By contrast, under present conditions, the length of the estuary has been reduced and now extends only from the dam to the tidal inlet. The sediments within the estuary for pre-dam conditions were most likely composed of sand and finer material and contained less gravel deposits than today.

The Eel River bar is a result of the hydrodynamic and sediment transport conditions in Eel Bay, reducing the tidal inlet width to only a small fraction of the width of the estuary. The sand bar is a result of littoral sediment transport along the coast. Littoral currents are set up by the action of waves striking the coast at an oblique angle, in this case from the southeast. Winds blowing from this direction have a greater fetch over open water in Chaleur Bay that promote the development of wind-generated waves from the southeast to strike the New Brunswick coast and to transport sediment. The source of sediment is most likely from wave action erosion of the coast further southeast (*i.e.*, towards the Village of Charlo) being moved by the littoral currents towards the north. The size and maintenance of the tidal inlet would be a function of the hydraulic flow through this opening that in turn is governed by the tidal range and water depths inside the inlet as well as the freshwater flows through it. Movement of sediment back and forth through the inlet also occurs due to tidal exchange and freshwater flow. This often results in fan-shaped sediment deposits and creation of water channels running through the deposits that are found both upstream and downstream of the tidal inlet and as observed for the Eel River estuary.

Although no bathymetric map could be found for inside the estuary prior to the dam construction in 1963, the Eel River estuary was most likely a relatively shallow estuary (< 5 m). This is based on the low topographic relief of adjacent lands and overall gently sloping embankments and shoreline of the estuary. The bridge structure on Route 134 was constructed seven years prior to the Eel River dam. The bridge spanned across the tidal inlet with a total opening width of about 100 m at a mean high tide elevation. This is wider than the present width. The historical cross section available in the design of the bridge structure indicated that the invert of the tidal inlet was at approximately - 1.8 m (geodetic) and about 0.8 m lower than the present invert elevation measured by the Jacques Whitford Study Team in 2004. Anecdotal information on the depth of water indicated that the tidal inlet and the lower reaches of the estuary were historically a regional swimming area before the construction of the dam because the river water was warmer than that of Eel Bay. At low tide, people could dive from the bridge on Route 134 into waters 2.5 m deep, and water holes 3 to 4.5 m deep could be found on the estuary side of the bridge on Route 134 (ERBFN, 2005). By contrast, under present day conditions, and according to ERBFN, one can cross the tidal inlet at low water and not have it go above the hips. The water holes are now exposed at low tide.

Prior to the construction of the Eel River dam, the impoundment constituted part of the Eel River estuary, and tidal flow from Eel Bay could reach the Village of Eel River Crossing. The volume of tidal flow moving into the Eel River estuary, which included the present impoundment, would have been substantially larger than under existing conditions. The tidal regime was likely the same as it is presently since it is caused by astronomical forces. The existing tide regime is described in Section 3.2.

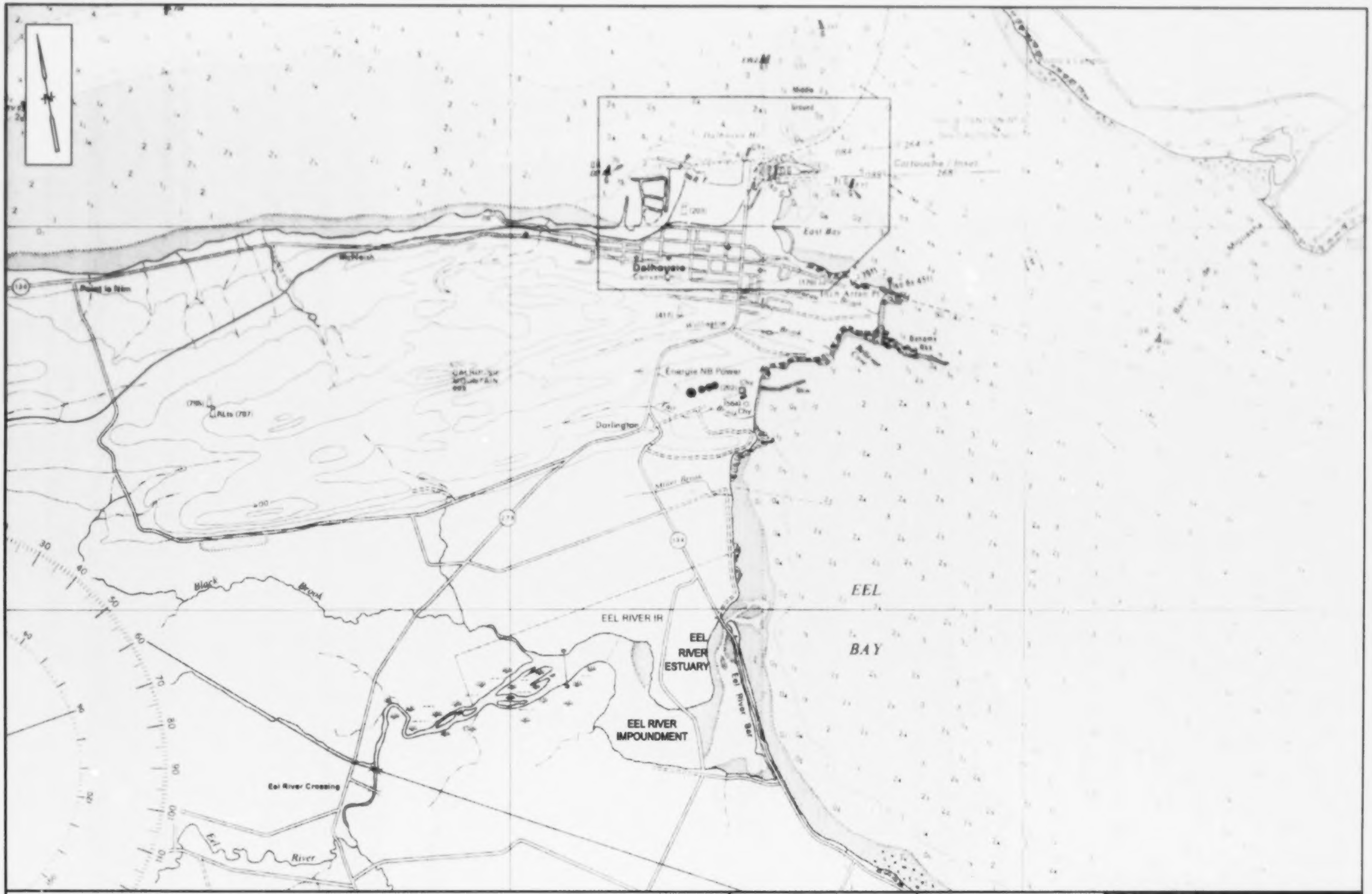
Sometime in the early 1900s to 1920s the Eel River bar was eroded and breached by a storm, making it impassable to traffic at high tide (Jacques, pers. comm.). This sand bar has been used as a highway since very early pioneer times.

3.1.2 Post-dam and Existing Conditions

The Eel River and its tributaries flow in an east-northeasterly direction and eventually discharge through a tidal inlet opening in the Eel River bar into Eel Bay, which is a coastal embayment approximately 8.5 km long and 3.5 km wide embedded to the west in the much larger Chaleur Bay. Chaleur Bay is the dominant marine environment in the vicinity of the proposed Decommissioning of the Eel River dam. This elongated bay along an east-west axis is bounded to the north by the Quebec coastline of the Gaspé Peninsula and to the south by the coastline of New Brunswick. Chaleur Bay is approximately 187 km long and 28 km wide at the eastern end and mouth of the bay where it forms part of the Gulf of St. Lawrence (Gregory *et al.*, 1993). This bay is the outward extension of the Restigouche River, but is also fed by several other major rivers (Grand Pabos, Port Daniel, Bonaventure, Petite Cascapedia, Cascapedia, Nouvelle, Jacquet and Nepisiguit rivers).

The water depths of Eel Bay surveyed by the Canadian Hydrographic Service in 1986 (Figure 3.1.1) range from 2 m to 5 m. The sea bottom of Eel Bay gently slopes from the shoreline going seaward and gradually increases in depth towards Chaleur Bay, exposing a relatively large area in Eel Bay at low tide that is primarily composed of gravelly sand with pockets of silty sand deposits in lower reaches (this study). Higher up in the intertidal zone and along the beach face where waves break, the bottom is composed of coarse sand and gravel deposits. Maximum water depths to the west and in the inner Chaleur Bay range from 6 m to 10 m compared to 90 m at the bay's mouth to the east (Gregory *et al.*, 1993). In general, the water depths increase more rapidly along the north shore of Chaleur Bay compared to the south shore.

FILE: 15830\EIA REPORT\WATER DEPTHS


Dalhousie
Cartouche / Inset
East Bay
Energie NB Power
Darlington
EEL
BAY
EEL RIVER IR
EEL RIVER ESTUARY
EEL RIVER IMPOUNDMENT
Eel River Bar
Black Brook
Eel River Crossing
Eel River
30
40
50
60
70
80
90
100
110

WATER DEPTHS IN EEL BAY (AFTER CHS NAUTICAL SURVEY CHART No. 4426) (DEPTHS SURVEYED IN 1986 ARE IN FATHOMS)	Date: 2006 03 31	Scale: N.T.S.
	Job No.: 15830	Fig. No.: 3.1.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

Tidal flow enters the Eel River estuary, the remaining estuarine portion below the dam, through the tidal inlet. Based on a cross section survey conducted for this study, the width of the tidal inlet at its narrowest section is approximately 30 m, which has been reduced by 70 m from an approximate width of 100 m during pre-dam conditions. The sea bottom of the tidal inlet and at the location of the bridge on Route 134 is at an elevation of approximately -1 m geodetic in 2004, which is shallower by about 0.8 m compared to before construction of the Eel River dam.

Eel Bay typically experiences two tidal cycles on a daily basis. The geodetic elevations for mean tides in Eel Bay as reported by Canadian Hydrographic Service for the Dalhousie water level monitoring station range from 1.1 m at high tide to -0.9 m at low tide. Large tides (*i.e.*, new or full moon tides) range from 1.7 m at high tide to -1.2 m at low tide. The highest water level ever recorded at the Town of Dalhousie station in 1964 and from 1973 to 1992 is 2.36 m, which occurred on October 26, 1980. The recorded tidal water level is the combined result of the tidal cycle, wind set-up, and local atmospheric pressure, but excludes the effect of wave action. Eel River estuary remained estuarine with the construction of the Eel River dam, and the water level in the Eel River estuary is predominantly affected by the tides in Eel Bay, and to a less extent by freshwater flow.

The major freshwater input to Chaleur Bay is the Restigouche River at the western end. Outflow from this river establishes an easterly current flowing along the New Brunswick coast. The surface current regime within the bay is easterly exiting along the New Brunswick shore and westerly entering the bay along the Gaspé side. These two opposing currents result in the domination of the surface current pattern by a cyclonic (anti-clockwise) gyre, centered between Port Daniel, Quebec and Caraquet, New Brunswick (Legendre and Watt, 1970; Hilderbrand, 1984). There are two major currents most likely influencing the Eel Bay area. The first one is the coastal current caused by freshwater runoff from the Restigouche River, as previously stated. The second is the longshore current produced by wave action on the shoreline, causing littoral drift and net sediment transport. Typical currents measured in 1964 in surface waters (0-10 m) near Belledune Point were approximately 10-20 cm/s and directed to the east and following the coastline (Canadian Hydrographic Service, 1965; WGA, 1989). The width of the current was estimated to be approximately 2 km. There are no data on estimates of longshore currents due to waves.

Estimated mean monthly discharge of freshwater into Chaleur Bay ranges from a high of approximately 3,000 m^3/s in May during spring runoff, to a low of 220 m^3/s in February during winter and ice-cover conditions. The lowest monthly discharge during the ice-free period occurs in August-September and is estimated at approximately 370 m^3/s (Gregory *et al.*, 1993). Data on the low flows during the low flow months of the year and maximum flood flow were not provided. Freshwater discharge and stream flow in Eel River exhibits similar significant seasonal fluctuations, with high flow typically experienced in April and May as a result of spring melt. Low freshwater flow is mainly experienced in the summer and winter. Estimated mean monthly discharge for May is 21 m^3/s, 1 m^3/s in February and 2 m^3/s in August-September. Therefore the overall freshwater discharge contribution of Eel River into Chaleur Bay is very small and in the range of 0.5 to 0.7 percent.

As for pre-dam conditions, waves washing over Route 134 on the Eel River bar during post-dam and existing conditions have occurred on a number of occasions as a result of storms in Chaleur Bay and combined with heavy precipitation, high waves and large tides. This generally tends to occur during fall-winter storms around October to December where east winds mixed with very high tides would generate storm surges that would wash over the road on Route 134 (Campbellton Tribune, 2003; Ayles, pers. comm.). It was necessary for NBDOT to close the road on the Eel River bar in more than one instance after some of these storms in order to clear the transported sand and wood debris with snowplows. At times the shoulder of the road up to the edge of the asphalt on Route 134 would also be washed out. The number of storms affecting Route 134 appear to be increasing and with greater severity in recent years, the last two occurring on December 2 and 9, 2005 (Ayles, pers. comm.). However, for the first time one storm in spring of 2005 temporarily closed Route 134. According to NBDOT, the storms affecting Route 134 are not consistently spaced in time and do not occur every year, but rather appear to occur for successive years followed by some years with no storm damage. It was noted during a site visit that homes in the Upper Village of Charlo area, about 2 km southeast of Eel River bar, had bank protection along banks which were obviously being attacked by wave action. Reportedly, in late 2003, a series of storms in October and November washed away large sections of land in the Village of Charlo area. NBDOT are currently installing rip-rap along the shoreline in the Village of Charlo as a result of severe weather storms that eroded the banks adjacent to the highway. The Geological Surveys Branch of NBDNR has initiated a coastal erosion study for the Village of Charlo area in 2004 (Bérubé, pers. comm.). This study will cover the entire shoreline of the Village of Charlo, as well as the fan shaped sand spit located at the mouth of Eel River (tidal inlet). Coastal erosion rates along beaches and dunes, using digital photogrammetry from aerial photos, will be used to conduct the study and to officially publish coastal erosion maps. Problems with Route 134 on the Eel River bar have not been observed or attributed to the construction or operation of the Eel River dam, freshwater runoff, tidal flow, or ice flows inside the estuary (Ayles, pers. comm.).

3.2 Physical Characteristics of the Eel River Estuary

3.2.1 Hydrodynamics

The hydrodynamic components of the current Eel River estuary include the freshwater flow, the impoundment, the Eel River dam and water control structure, the Eel River estuary, the tidal inlet, and the tides in Eel Bay. All of these components contribute to the hydrodynamic characteristics of the Eel River estuary. A brief discussion of these hydrodynamic components under the existing and pre-dam conditions is provided as follows.

3.2.1.1 Eel River Watershed and Freshwater Flow

3.2.1.1.1 Pre-dam Conditions

The pre-dam freshwater flow in Eel River and predominant land use in Eel River watershed was similar to the present conditions.

3.2.1.1.2 Post-dam and Existing Conditions

The drainage area of the Eel River watershed above the Eel River dam is approximately 220 km^2. Currently, there is a hydrometric station on Eel River near Dundee (Unincorporated) (the upstream drainage area is approximately 43.2 km^2) that has been in operation since 1984. Another hydrometric station was operated on the Eel River from 1967 to 1983 near the Village of Eel River Crossing (the upstream drainage area is approximately 88.6 km^2). The locations of these hydrometric stations are shown in Figure 1.1.1. Using the stream flow records from the two hydrometric stations, the average annual stream flow draining into the Eel River impoundment is estimated to be approximately 5 m^3/s. The maximum and minimum daily stream flow for the record period ranges from 140 m^3/s to 0.2 m^3/s.

Similar to rivers in the Maritime Provinces, the stream flow in Eel River exhibits significant seasonal fluctuations, with high flow typically experienced in April and May as a result of spring melt. Low fresh water flow is typically experienced in the summer and winter. The typical monthly stream flow distribution near the Eel River dam, as prorated using the flow records for the two hydrometric stations indicated above, is presented in Figure 3.2.1.

The predominant land use in the Eel River watershed is forest resource harvesting. There is a small amount of mixed agriculture in the lower portion of the watershed. Given the predominant land use in the watershed, the rate of sedimentation of the impoundment and estuary below the dam is considered to be small.

3.2.1.2 Impoundment and Estuary Below the Dam

3.2.1.2.1 Pre-dam Conditions

Prior to the construction of the Eel River dam, the tidal flow from Eel Bay could reach the Village of Eel River Crossing (Figure 3.2.2). The tidal volume associated with a mean tide (elevation 1.1 m) was estimated to be about 1.9 million m^3, and 3.2 million m^3 for a large tide (elevation 1.7 m). There are little survey data for the Eel River estuary prior to the construction of the Eel River dam to establish the actual volume of the tidal prism for the pre-dam conditions.

Prior to the construction of the Eel River dam, the Eel River estuary experienced water level fluctuations as far upstream as the Village of Eel River Crossing influenced by the tidal cycles, similar to that of the estuary below the dam at the present time.

3.2.1.2.2 Post-dam and Existing Conditions

The impoundment was created in 1963 through the construction of the Eel River dam. The dam was initially constructed to have a maximum operating water level of 1.98 m (BMA and CG&S, 2000). At this level, the impoundment has a storage volume of 2.8 million m^3. Currently, the impoundment consists almost entirely of freshwater, (Figure 3.2.1) with a slight amount of salt water infiltration through the dam and salt water intrusion over the top of the gates during extreme large tides (Guitard, pers. comm.). Generally speaking, the water level in the impoundment is seldom affected by the tides in Eel Bay.

The estuary below the dam remained estuarine with the construction of the dam, and the water level in this area is predominantly affected by the tides in Eel Bay, and to a less extent by freshwater flow. For a mean tide, the estuary below the dam has a total storage volume of 0.59 million m^3. For a large tide, the storage volume in this area is increased to 0.92 million m^3. Tidal flow from Eel Bay is not able to migrate beyond the Eel River dam because of this barrier, except by infiltration or by overtopping during extreme high tides.

3.2.1.3 Eel River Dam and Water Control Structure

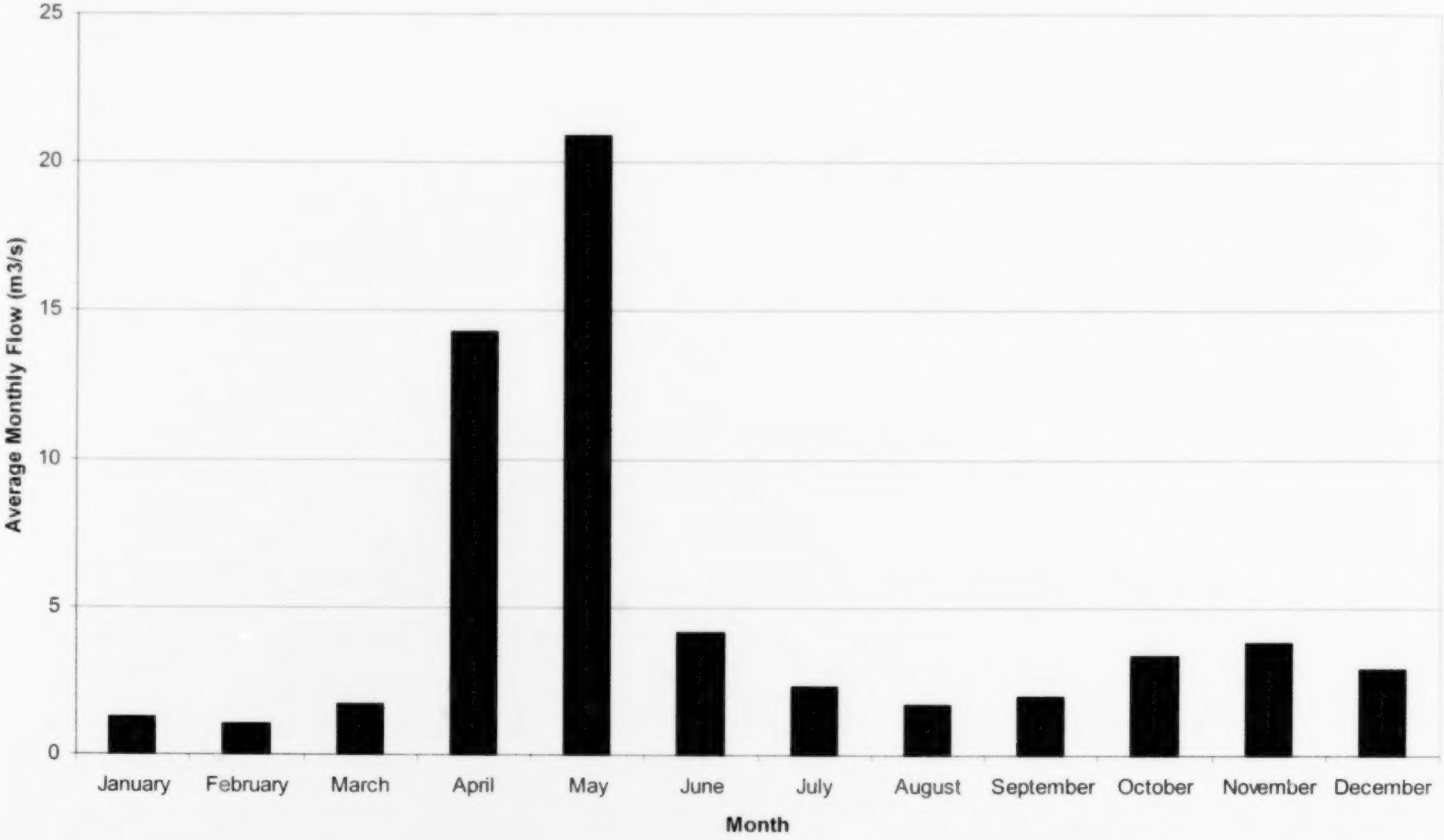
3.2.1.3.1 Pre-dam Conditions

Eel River dam, the control structure, and fishway were not present prior to 1963.

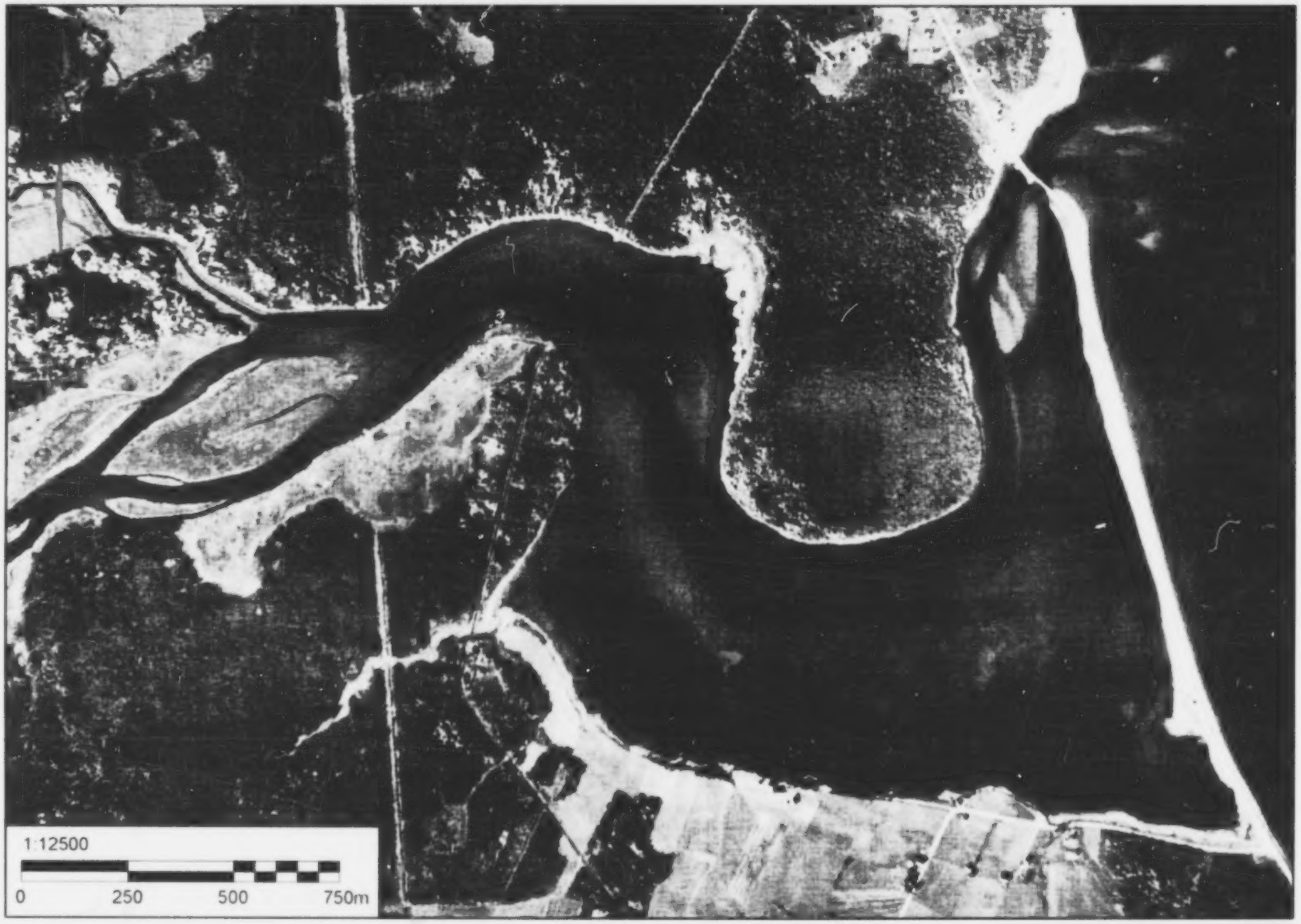
3.2.1.3.2 Post-dam and Existing Conditions

Eel River dam has a total length of 600 m and is of earth fill construction. A photo of the dam (Figure 4.1.1) and a more thorough description of the fishway is presented in Chapter 4. The crest of the dam was constructed to an elevation of 3.4 m. The water control structure is located adjacent to the south shore of the Eel River estuary. It consists of six 3.66 m wide bays equipped with vertical steel gates and one 1.83 m wide fishway. The steel gates can be lifted to discharge flow from underneath the gates. Operation of the gates is through a track mounted motorized hoist. When fully opened at low tide, the gates are estimated to have a total discharge capacity of approximately 240 m^3/s. Stop logs can also be added on top of the steel gates to increase storage in the impoundment. Through these gate operations flood inflow into the impoundment can be released and the desired storage can be maintained. The sill of the bays is at an approximate elevation of -0.91 m.

One of the gates located adjacent to the fishway is equipped with a trapezoidal shaped weir section. The weir opening is approximately 0.4 m high, 0.6 m wide at the bottom and 1.2 m wide at the top. The weir was installed a few years ago under guidance of DFO, to enhance fish passage for the upstream migration of adult salmon. The weir has worked well for salmon and trout (Madden, pers. comm).



Monthly Flow Distribution at Eel River Dam	Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **3.2.1**	NBDSS PROJECT No. YR101A



A 1955 Aerial Photograph of the Lower Portion of the Estuary of Eel River

Date:
03/31/2006

Scale:
As Shown

Job No.
15830

Figure No.
3.2.2

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

Brunswick

NBDSS PROJECT No. YR101A

The Eel River dam was completed in 1964 to have a maximum operating water level of 1.98 m. During 1968 and 1969, the dam was modified to increase the water storage capacity of the impoundment by increasing the operating water level by approximately 1 m, to approximately 2.98 m (BMA and CG&S, 2000).

The fishway is designed to facilitate upstream fish passage and consists of three pools divided by four baffles. A rectangular shaped notch is situated on top of each baffle. The baffle separating the first pool and the impoundment has a 0.33 m diameter circular opening designed for fish passage. The invert elevation of the opening is at 0.76 m.

3.2.2 Bathymetry

3.2.2.1 Pre-dam Conditions

Little information is available to clearly define the pre-dam bathymetry of the estuary between Eel Bay and Eel River Crossing. An examination of the pre-dam aerial photographs (1945 and 1955) and bridge drawings indicates that the net opening of the tidal inlet at Eel River bar was in the order of 90 m at mid-tide level (Figure 3.2.2). Based on available bridge drawings, the bed of the channel was at elevation -1.8 m. Substantial amounts of material, probably sand and gravel, were deposited in the Eel River estuary to at least 400 m upstream of the bridge.

The thalweg (the line drawn through the lowest points of a valley or water course in its downward slope and thus marks the natural bottom and direction of a watercourse) and the main channel upstream of the bridge followed the north bank of the estuary up to and around Blueberry Point. These details are shown on the 1955 aerial photograph (Figure 3.2.2). The tidal effects of the estuary extended up to at least the railway bridge at Eel River Crossing, a distance of about 4,500 m upstream of the present dam.

The bottom elevations in the estuary above the existing dam will have changed little after 1963 when the dam was constructed. At the cross section along the pipeline crossing, there is some evidence that infilling resulting from the deposition of sediment supplied from upstream has taken place in the location of the previous channel. The estimated maximum volume of deposition in the impoundment is about 60,000 m^3 or in the order of 2 percent of the initial volume for a large tide at elevation of 1.7 m (3.2 million m^3). Hence, the pre-dam bathymetry is considered to be essentially the same as the current bathymetry. Based on an interpretation of the aerial photograph in Figure 3.2.2, the thalweg in the impoundment was more or less in the same location as it is at the present time.

The aerial photograph taken in August 2005 (Figure 3.2.3), when many of the bathymetric features in the impoundment were exposed due to abnormally low water level, provides very good information to compare the bathymetric features at the present time with those prior to the construction of the dam. As can be seen from a comparison with the 1955 (8 years before the dam was constructed) aerial photographs shown in Figure 3.2.2, the extent and location of the sand and gravel deposits in the estuary below the dam, just upstream of the bridge at the tidal inlet, has altered over time. In 1955, the larger channel was present on the northwest side of the upstream deposits whereas in 2005 the larger channel was along and parallel to the Eel River bar and Route 134. The entrance/exit to the estuary at the tidal inlet downstream of the Route 134 bridge has narrowed as a result of the infilling with sand and gravel. The width of the pre-dam low water channel in the tidal inlet was estimated to be approximately 50 m from the 1945 and 1955 aerial photographs and the pre-dam bridge drawings as compared to about 16 m in 2004. At mean water level at 0.0 m (geodetic), the pre-dam width of the tidal inlet was approximately 90 m, whereas the width was about 30 m in 2004. The approximate bed elevation of the tidal inlet in the vicinity of the bridge crossing on Route 134 in 1955 was -1.8 m (geodetic).

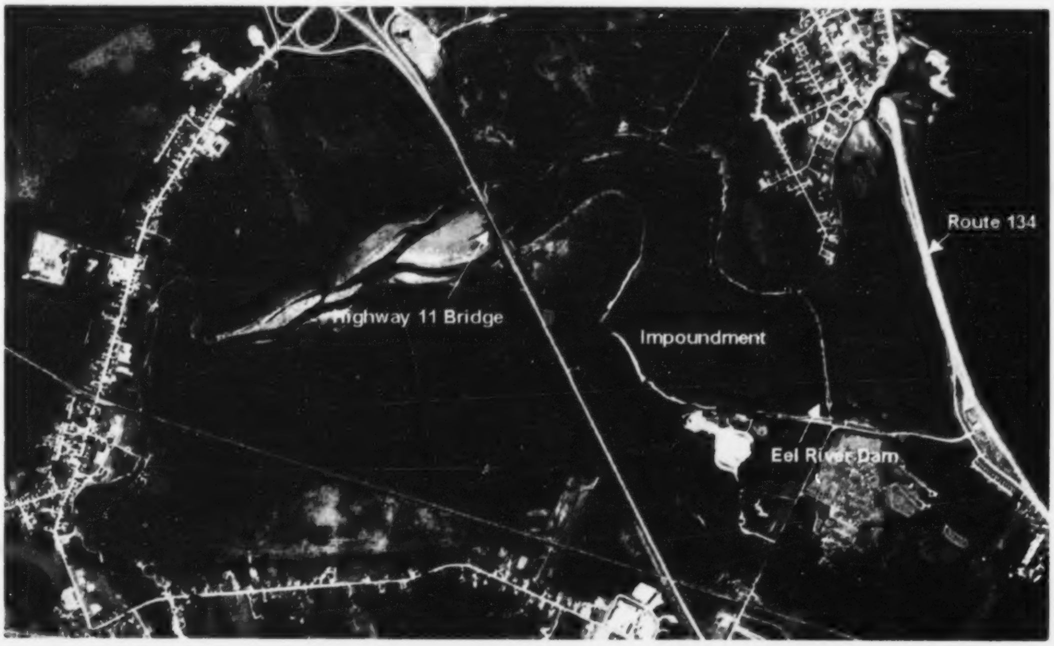
A comparison of the aerial photographs indicates that a scour hole has developed immediately below the water control structure as a result of flow discharge. A channel has developed along the toe of the dam. Despite these changes, the extent and main features of the sediment deposit in the estuary below the dam has remained very similar for approximately 50 years. The bathymetric features in the impoundment area have also remained virtually the same. These observations are indirect indications that the sediment input into the impoundment and the estuary below the dam is typically low.

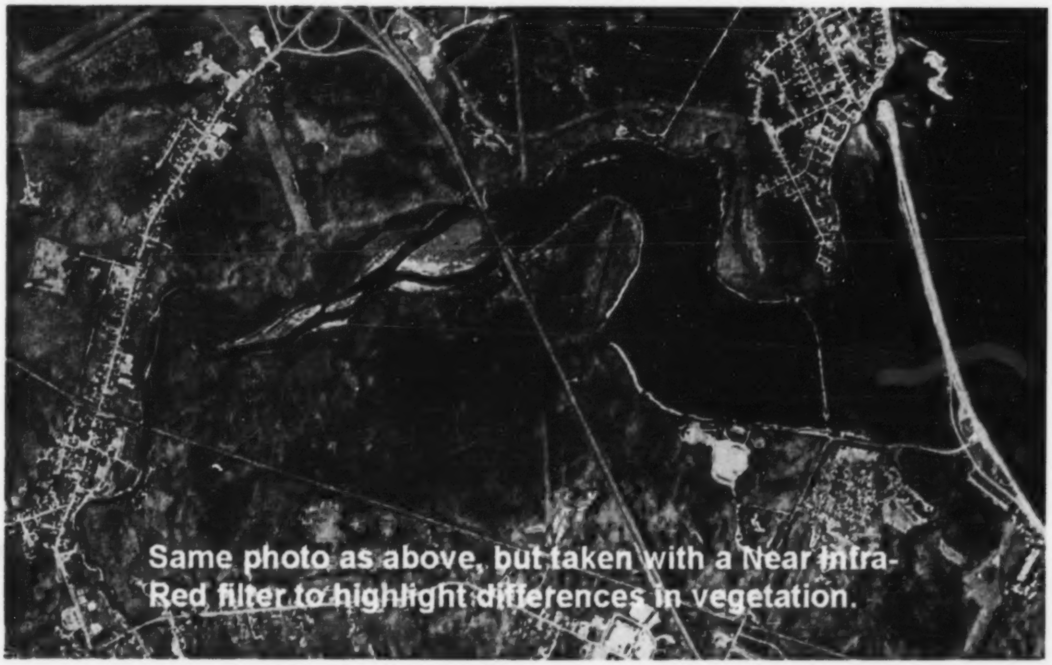
3.2.2.2 Post-dam and Existing Conditions

Details of the existing conditions and the longitudinal section along the estuary and the impoundment are shown in Figure 3.2.4, and on the 2005 aerial photograph in Figure 3.2.3. The 2005 aerial photograph consists of two images, one of natural colour and the other of infrared. The aerial photograph was taken in August when the water level in the impoundment was abnormally low (approximately 0.74 m geodetic) due to leaky stop logs. The locations of the cross sections taken for this study in 2004 are shown on the site plan in Figure 3.2.4. The location and elevation of the thalweg in the tidal inlet, the estuary below the dam and the impoundment are included.

For the Assessment Area upstream of the dam, the bottom slope is essentially flat. The thalweg elevation varies from -0.10 m just upstream of the dam to a high of +0.0 m at Section 7 located 850 m upstream of the dam and a low of -0.45 m at Section 2 located 3,190 m upstream of the dam. Before the dam was constructed, the channel geometry of the upper section of the present impoundment was controlled by river flow rather than tidal flow, which may be the reason for the deeper thalweg in this portion of the channel. The maximum depth of water in the impoundment is in the range of 1.8 to 2.0 m relative to an operating level of 1.8 m (geodetic).

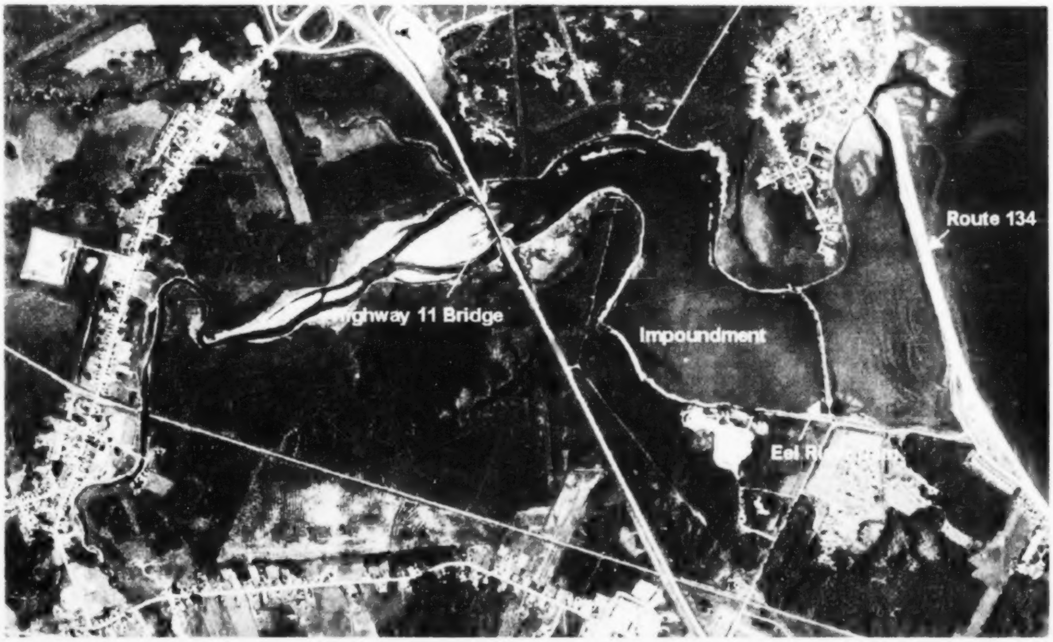
Aerial Photo of Eel River Taken August 19, 2005 with Low Water Level Upstream of the Dam

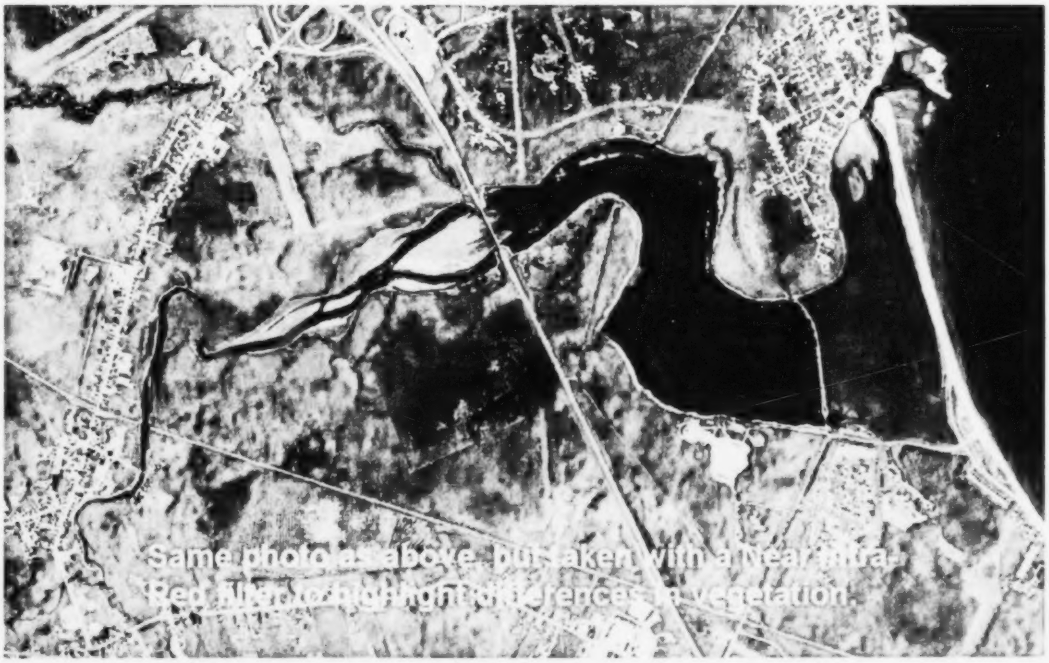

Route 134
Highway 11 Bridge
Impoundment
Eel River Dam


Same photo as above, but taken with a Near Infra-Red filter to highlight differences in vegetation.

A 2005 Aerial Photograph of the Lower Portion of the Estuary of Eel River	Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **3.2.3**	NBDSS PROJECT No. YR101A

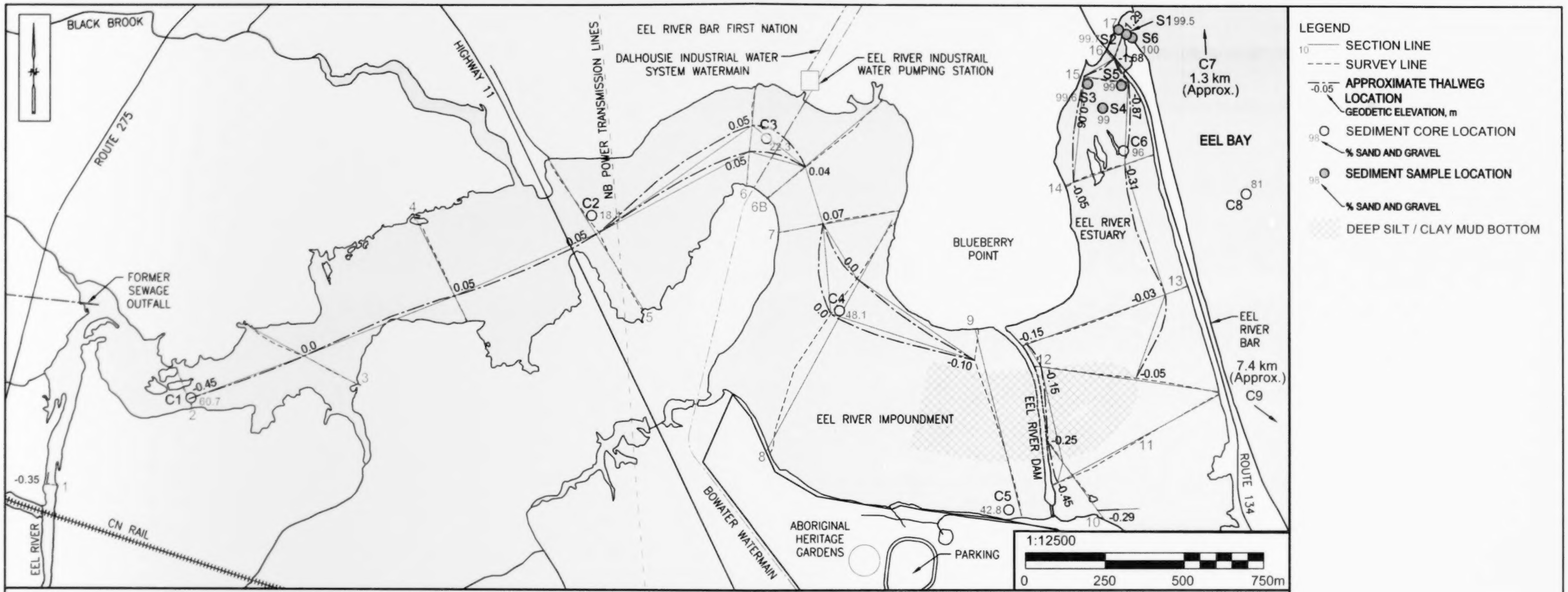
Aerial Photo of Eel River Taken August 19, 2005 with Low Water Level Upstream of the Dam

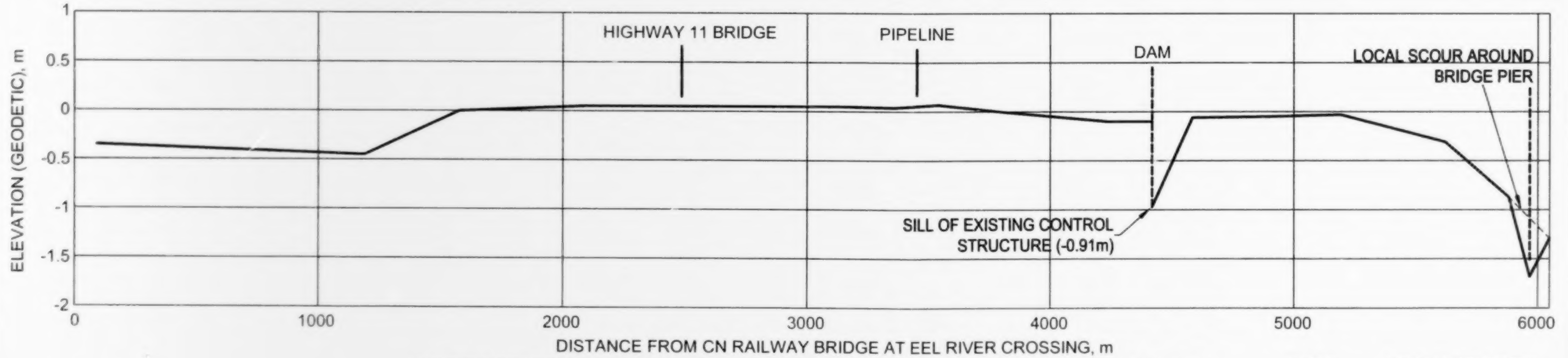

Route 134
Highway 11 Bridge
Impoundment
Eel R



Same photo as above, but taken with a Near Infra-Red filter to highlight differences in vegetation.

A 2005 Aerial Photograph of the Lower Portion of the Estuary of Eel River	Date: 03/31/2006	Scale:	Eel River Dam
	Job No. 15830	Figure No. 3.2.3	NBDSS PROJECT No. YR101A


BLACK BROOK
ROUTE 275
HIGHWAY 11
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
FORMER SEWAGE OUTFALL
C1 60.7
C2 18
C3 22
C4 48.1
C5 42.8
C6 96
C7 1.3 km (Approx.)
C8 81
C9 7.4 km (Approx.)
S1 99.5
S2 99
S3 99.6
S4 99
S5 99
S6 100
EEL BAY
EEL RIVER ESTUARY
BLUEBERRY POINT
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
EEL RIVER BAR
ROUTE 134
BOWATER WATERMAIN
ABORIGINAL HERITAGE GARDENS
PARKING
CN RAIL
EEL RIVER
1:12500
0 250 500 750m
LEGEND
SECTION LINE
SURVEY LINE
APPROXIMATE THALWEG LOCATION
GEODETIC ELEVATION, m
SEDIMENT CORE LOCATION
% SAND AND GRAVEL
SEDIMENT SAMPLE LOCATION
% SAND AND GRAVEL
DEEP SILT / CLAY MUD BOTTOM



LONGITUDINAL PROFILE OF THE EEL RIVER FROM THE CN RAILWAY BRIDGE AT EEL RIVER CROSSING TO THE TIDAL INLET ALONG THE POST-DAM THALWEG.

SCALE: 1:20000 HORIZONTAL
1:50 VERTICAL

NOTE:

LOCATION OF SEDIMENT SAMPLING STATIONS AND SECTIONS IN 2004

Date:	Scale:
2006 03 31	AS SHOWN
Job No.: 15830	Fig. No.: 3.2.4

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

FILE: 15830\EA REPORT\SITE-SECTION

Immediately downstream of the dam the thalweg location is now indeterminate. There is a low linear feature just downstream and parallel to the toe of the dam. The bottom elevation of this feature, which slopes in a southerly direction, ranges from -0.15 m to -0.45 m. Observations during the late winter showed that flow was occurring along this feature in an open lead in the ice. A large scour hole has formed immediately downstream of the control structure. The elevations of the gate sills at the control structure range from -0.86 m and -0.97 m, with an average elevation of -0.91 m. Although no detailed data were obtained to clearly define the scour hole geometry, the bottom elevation must be below -0.97 m. Much of the eroded material from this scour hole is mounded downstream of the scour hole as might be expected. The mound directs flow along the south bank of the Eel River estuary and also in a northeasterly direction. Some erosion is occurring along the south bank just downstream of the control structure.

The tidal inlet currently has a width of about 30 m at the mean tide elevation and a bottom elevation of about -1.0 m.

3.2.3 Geomorphology

3.2.3.1 Pre-dam Conditions

The Assessment Area is characterized by a bar of sand and gravel extending across about 98 percent of its lower portion, and a narrow tidal inlet at the north end of the bar. The tidal inlet is a characteristic feature associated with littoral sediment transport along a coast. Littoral currents are set up by the action of waves striking the coast at an oblique angle, in this case from the southeast. The source of sediment is most likely from wave action erosion of the coast further southeast (*i.e.*, towards the Village of Charlo).

An active tidal inlet is characterized by movement of sediment back and forth through the inlet due to tidal exchange and freshwater flow. Deposition occurs just upstream or downstream of the inlet and changes in size and volume continuously. If a large storm event should cause extensive littoral transport toward the inlet, the tidal flow will work to maintain the opening at a relatively constant size, although it may take several tidal cycles to re-establish the pre-storm equilibrium geometry.

The tidal inlet size is a function of the hydraulic flow that in turn is governed by the tidal range and bathymetry inside the inlet as well as the freshwater flows. Prior to construction of the dam across the lower portion of the Eel River estuary, the tidal volume associated with a mean tide (elevation 1.1 m) was estimated to be about 1.9 million m^3 and the tidal volume associated with a large tide (elevation 1.7 m) was estimated to be 3.2 million m^3. These estimates were based on the 2004 surveys of the estuary below the dam and the impoundment. The assumption is made that the bathymetry did not change appreciably over the period 1963 to 2004. Other computations presented earlier in this section show that the pre-dam tidal volume for a specified high tide may have been about 3 percent larger than that in 2004.

Based on the results of the hydrodynamic model developed for this study, the computed pre-dam maximum tidal inflow and outflow for a large tide (elevation 1.7 m) and for a mean flow from the land were 321 m^3/s and 292 m^3/s, respectively. These may be compared to rough estimates obtained by the method presented by Neill (1984) for an "effective" tidal cycle of 7 hours for this estuary that is not flooded for a full tidal cycle. The comparable tidal discharges for a large tide and a mean tide are 398 m^3/s and 236 m^3/s, respectively. These discharges at the tidal inlet, which occur approximately twice a day, can be compared to a mean daily fresh water flow of 5 m^3/s and an average freshwater flood (2-year flood or average annual flood) flow of 60 m^3/s. It is clear that the size of the tidal inlet is a function mainly of the tidal flow. The pre-dam width of the tidal inlet was about 90 m based on available bridge drawings at the site. The bed elevation was about -1.8 m (geodetic).

3.2.3.2 Post-dam and Existing Conditions

The construction of the Eel River dam resulted in a large reduction of the tidal volume which enters and exits the estuary at the tidal inlet. The ratio of the pre-dam volume to the existing volume is about 3.2 for a mean tide of 1.1 m (geodetic) and by a factor of about 3.6 for a large tide of 1.7 m (geodetic). For this discussion, the geometry of the tidal inlet is assumed to be related to the flows associated with a large tide.

The major changes of the reduction in the tidal prism after the construction of the dam have been the narrowing of the channel at and downstream of the bridge on Eel River bar, and a partial closure of the northern channel above the bridge. The main flow now occurs in a channel that is almost parallel to the bar and flows northward towards the bridge during ebb tide conditions. From a review of the aerial photographs, the reduction in the size of the tidal inlet appears to have been essentially complete between 1974 and 1985, some 10 to 20 years after construction of the dam. However, some reconfiguration of the upstream channel was still occurring between 1985 and 1997.

Based on limited pre-dam surveys, there is some evidence that a small amount of infilling has occurred in the pre-dam channel in the vicinity of the pipeline crossing about 1,100 m upstream of the dam. The maximum amount of infilling is roughly estimated to be about 1.5 m, with an average infilling of about 0.7 m over a 100 m portion of the channel width at that site.

This infilling is assumed to be primarily associated with the deposition of suspended sediment supplied from the watershed upstream of the Village of Eel River Crossing. Using a methodology developed by Bray and Xie (1993) for estimating suspended sediment yields from ungauged watersheds in Atlantic Canada, the estimated long-term annual suspended sediment load entering the impoundment is about 3,300 tonnes/year. For the storage and inflow characteristics of the impoundment, it is estimated that a maximum of 65 percent of the incoming sediment is trapped in the impoundment. That is about 2,100 tonnes per year, or about 1,400 m^3 per year. The bulk density of the deposited material is assessed to be 1,500 kg/m^3.

If it is assumed that the area of deposition in the impoundment is primarily along the pre-dam channel, with a width of 100 m and a length of 2,000 m, then the annual deposition would be about 7.0 mm/year and the total deposition over the 41-year period between 1963 and 2004 would be about 0.29 m. This estimate of the depth of deposition is similar to the estimate made near the Bowater pipeline crossing in the impoundment. If it is assumed that the trapped suspended sediment is deposited over the entire impoundment bottom with a width of about 300 m and a length of about 4,000 m, then the estimated depth of deposition would be in the order of 0.05 m over the 41 year period or about 3 percent of the volume below the elevation of a large tide of 1.7 m. Another estimate of the reduction in volume may be made by comparing the estimated total deposition of suspended sediments in the impoundment over the 41-year period (57,400 m^3) to the volume above the dam below an elevation of 1.7 m (2.3×10^6 m^3). In this case the volume of deposition is estimated to be about 2.5 percent of the total volume of the impoundment.

3.2.4 Tidal Regime

3.2.4.1 Pre-dam Conditions

The dam construction has had no effect on the tides of Eel Bay. The sand bar at the mouth of the Eel River estuary existed prior to the construction of the Eel River dam in its present form. However, the tidal inlet had a total width of approximately 100 m, wider than at present. The bridge structure constructed seven years prior to the Eel River dam spanned across the tidal inlet with a total opening width of about 100 m at a mean high tide elevation. The historical cross section available in the design of the bridge structure indicated that the invert of the tidal inlet was at approximately -1.8 m, approximately 0.8 m lower than the present invert elevation.

3.2.4.2 Post-dam and Existing Conditions

Eel Bay typically experiences two tidal cycles on a daily basis. The geodetic elevations of the characteristic tides in Eel Bay as reported by Canadian Hydrographic Service are summarized in Table 3.2.1.

Table 3.2.1 The Geodetic Elevations of the Characteristic Tides in Eel Bay as Reported by Canadian Hydrographic Service

Type of Tide	Tide Characteristics	Geodetic Elevation
Large Tide	Higher High Water	1.7 m
	Lower Low Water	-1.2 m
Mean Tide	Higher High Water	1.1 m
	Lower Low Water	-0.9 m

Canadian Hydrographic Service operated a tidal water level monitoring station in the Town of Dalhousie in 1964, and from 1973 to 1992. The highest tide ever recorded at this station is 2.36 m, which occurred on October 26, 1980. The recorded tidal water level is the combined result of the tidal cycle, wind set-up, and local atmospheric pressure, but excludes the effect of wave action. The extreme tide elevation is lower than the crest elevation of the Eel River dam, but is higher than the gate crest elevations when stop logs are not installed. The Town of Dalhousie (Kingston, pers. comm) indicated that, on occasions, salt water has risen above the crest of the gates and spilled into the impoundment.

Tidal flow enters the estuary below the dam through the tidal inlet. The lower end of the estuary below the dam has a total width of approximately 1,500 m when measured parallel to the shore of Eel Bay. However, a natural sand and gravel bar has formed at the mouth of Eel River estuary as a result of the hydrodynamic and sediment transport conditions in Eel Bay, reducing the tidal inlet width to only a small fraction of the width of the estuary. Based on a cross section survey conducted for this study, the width of the tidal inlet at its narrowest section is approximately 30 m. The invert of the tidal inlet is at an elevation of approximately -1 m.

3.2.5 Flooding

3.2.5.1 Pre-dam Conditions

Prior to the construction of the Eel River dam, areas adjacent to the present impoundment could have been subject to flooding caused by extreme high tide, which can reach an elevation of 2.36 m. The tidal water level could, on occasions, have been higher than the water level typically maintained in the impoundment. The ballfield adjacent to Eel River in the Village of Eel River Crossing was occasionally flooded (Bujold, pers. comm.). Any flooding caused by extreme high tide would be short in duration, and would recede with the falling tide.

3.2.5.2 Post-dam and Existing Conditions

In conjunction with construction of the Eel River dam, the Province of New Brunswick purchased properties adjacent to the impoundment in the Village of Eel River Crossing due to flooding risk considerations. Some homes were relocated. This appears to indicate that the typical high water level in the impoundment area prior to the construction of the Eel River dam was lower than the water level currently maintained for the impoundment. No other data on flooding in the impoundment are available.

Water level in the impoundment is currently regulated by the water control structure incorporated into the Eel River dam along the southern end of the dam, which also protects the impoundment area from flooding resulting from extreme high tide. The dam was initially designed to have a maximum operating water level of 1.98 m. During a dam modification in 1968 and 1969, the potential storage capacity of the impoundment was increased by 1.0 m (BMA and CG&S, 2000), which would increase the maximum operating water level to 2.98 m. It is not known if the impoundment has been operated at this level. Design information regarding the selection of this maximum operating water level is not available.

3.2.6 Ice Regime

3.2.6.1 Pre-dam Conditions

The ice cover in Eel Bay and Eel River estuary in the pre-dam period is expected to have been similar to the present condition. Because the impoundment area would be subject to tidal inflow and tidal water fluctuations, ice formation in the current impoundment area would have been somewhat later, and the ice cover would have been somewhat thinner, than under existing conditions. The ice cover in the area of the current impoundment would also have been subject to "hinging" at the banks in response to tidal fluctuations, especially during the early part of the winter season. Later in the winter, the "hinging" would have been less evident and the volume of the tidal exchange would have been less since the vertical extent of the ice would have greatly increased and in some areas would have reached the bottom of the estuary.

3.2.6.2 Post-dam and Existing Conditions

During the winter months, an ice cover forms over much of Eel Bay and an ice cover forms over much of the estuary below the dam and over all of the impoundment above the existing dam. Because the dam prevents tidal salt water from penetrating into the impoundment area, the ice in the impoundment is freshwater ice, probably forming earlier and being somewhat thicker than ice formed in a typical tidal estuary in this region of the Province. Because the impoundment level is stable, the ice cover would also be stable and not subject to "hinging" at the banks that occurs in response to tidal fluctuations in a typical estuary in this region, especially early in the winter period.

On March 27, 2005 several photographs were obtained to show the ice cover conditions at the tidal inlet and in the estuary below the dam. By this time late in the winter, it appears as though much of the estuary below the dam is infilled with ice such that the ice is grounded on the bed of this area during much of the tidal cycle. A narrow channel was open from the outlet of the control structures in the dam to the tidal inlet. The open channel was orientated along the downstream face of the dam and led to the tidal outlet. If much of the area in the estuary below the dam is filled with ice from top to bottom, then the actual volume of tidal exchange during the late winter is relatively small compared to that during ice-free periods.

Early in the season there is an "ice hinge" that forms where the ice cover meets the banks of the estuary. Where ice cores have been obtained, it has been found that the ice cover in these estuaries has a thickness that is slightly less than or about the same as that for river ice, typically around 0.6 m. It has also been found that the strength of the ice in these estuaries is slightly lower than or about the same as that for river ice. However, no direct measurement of ice thickness or ice strength has been obtained for the estuary below the dam and impoundment.

Photographic evidence indicates that there is little lateral movement of the ice cover in the estuaries in the eastern and northern portion of the Province. Photographs taken in March 2005 at bridge sites in the Richibucto and the Bouctouche estuaries show the ice cover interacting with bridge piers in portions of the estuary that are unconstricted. These images indicate that there is no crushing of the ice cover at the ice-pier interface. These observations indicate that there is no significant lateral motion and the inference is made that the ice tends to melt in place. Because of the relatively high velocities at bridge openings at constricted cross sections, the ice thickness is less in these local areas.

Another observation is based on the lack of information concerning ice movement in these estuaries along the north and east coasts of the Province. Where there are problems, there tends to be an appreciable amount of information in the files of the NBDOT. The NBDOT does not have documentation of ice-related problems at the bridge crossing at Route 134 at the tidal inlet leading into the estuary below the dam. The lack of such information is an indication that the winter ice regime does not result in conditions of concern to NBDOT.

The major ice related problem along the east and north coasts of the Province is that associated with storm surge during the period in which an ice cover forms on the sea side of the coast. During periods of high winds and high tides, the ice is shoved on shore. This has been documented at the Town of Beresford, located about 65 km to the south east of Eel River bar. In February 2003, ice was pushed on shore, fractured and piled up to a height of about 6 m in the Beresford area. Such an event could also occur in the Eel River bar area.

If ice was pushed up on Eel River bar during a storm surge condition, it could stop traffic flow on Route 134, restrict the flow of water into and out of the tidal inlet, but it would not cause any physical problems upstream of the Route 134 bridge at the tidal inlet. The pile of fractured ice in the tidal inlet would be "thermally" eroded by water passing in and out of the tidal inlet and after a few tidal cycles the hydrodynamic regime would return to the pre-storm surge conditions. The impact of storm surge effects during the winter will essentially remain unchanged whether the dam is left in place or removed.

3.3 Atmospheric Environment

The Atmospheric Environment is the component of the environment that comprises the layer of air near the earth's surface to a height of approximately 10 km. The Atmospheric Environment is typically characterized by three key aspects: air quality; climate; and sound quality (noise). In the context of this EIA study, these are further augmented by odour as a fourth key aspect.

The pre-dam and existing conditions with respect to climate, air quality, sound quality, and odour in the Assessment Area are summarized in this section. For the purposes of characterizing these key aspects, the pre-dam period refers to the time frame prior to dam construction to a maximum of thirty years, whereas existing conditions are defined for the time period immediately following dam construction through to the present day. The spatial boundaries for the characterization of pre-dam and existing conditions may also vary from regional to local scales, depending on each key aspect.

It should be noted that due to the unavailability of information and/or data gaps, some aspects of the Atmospheric Environment could not be characterized wholly or in part for pre-dam and/or existing conditions. In this regard, wherever possible, these key aspects and their associated issues were addressed qualitatively, based on professional judgment and experience.

3.3.1 Climate

The climate of an area usually refers to long-term trends in weather for time periods which may range from months to centuries, or the more widely recognized 30-year time frame as advocated by the World Meteorological Organization. The climate and its trends may be applicable to large geographic regions such as counties and provinces, as well as to smaller areas such as a city or town. In recent times, the global climate is thought to have undergone discernible changes as a result of human, industrial and urban growth. Growth in these areas has increased the concentrations of greenhouse gases, including carbon dioxide, methane, and nitrous oxide, which contribute to the global greenhouse effect, also known as global warming. In addition, global climate change may also be influenced by the loss of sources of carbon sequestration or storage (*i.e.*, carbon sinks), such as forests and soils, from human activities like deforestation and agriculture.

A discussion of climate in the Assessment Area and surrounding region is provided below for pre-dam and existing conditions.

3.3.1.1 Pre-dam Conditions

General climate characteristics, such as regional climate trends and influences, are long-term conditions, and as such are not expected to have discernibly changed over the relatively short time frames defined as the pre-dam and existing periods.

The general climate of Canada's Atlantic provinces can be characterized by a series of high and low pressure systems, which are formed with the confluence of southward drifting cold dry air from northern Canada and poleward flowing warm moist air from the Caribbean. The climate of New Brunswick has been typically classified as continental, with a significant maritime influence, due to its close proximity to the Atlantic Ocean. The climate of northern New Brunswick experiences both maritime and continental influences characterized by cool summer and cold winter temperatures.

Prevailing winds over Atlantic Canada are primarily westerly to north westerly in winter, and south to southwesterly in summer (Bowyer, 1995). The region also receives large amounts of precipitation due to the proximity of the Atlantic Ocean and frequent low pressure systems (Environment Canada, 1997), with the Fundy coast of New Brunswick receiving the greatest annual amounts of precipitation in the province at more than 1,400 mm. Northern New Brunswick receives less precipitation, but still in excess of 1,000 mm annually. Atlantic Canada also experiences some of the thickest and longest lasting fogs in the world (Bowyer, 1995), with the highest frequency occurring over the Grand Banks and the Bay of Fundy. The southwestern Gulf of St. Lawrence, including northern New Brunswick, tends to have a much lower frequency of fog events because of the relatively warmer water temperatures and dry air flowing off the land.

The climate and weather patterns in the Assessment Area are affected by warm maritime air masses in the summer from Chaleur Bay and cold continental Arctic air masses from the west in winter. The close proximity of Chaleur Bay provides a moderating effect on temperatures in the summer. However, the same moderating effect is not apparent during the winter due to prevailing westerly winds that can lead to very cold winter conditions (Environment Canada, 2004c). Humid air masses from Chaleur Bay and Gulf of St. Lawrence waters bring considerable precipitation to the region during the summer. Precipitation, mostly in the form of snow, is also very frequent in the winter due to the confluence of continental Arctic air masses from the west and warm maritime tropic air originating from the Gulf of Mexico.

It should be noted that climate data were not available for pre-dam conditions for the Assessment Area, or for the nearby communities of Charlo and Dalhousie. The meteorological station nearest to the Assessment Area during the pre-dam time period was located in the Town of Campbellton. Therefore, in consultation with Environment Canada (Morin, pers. comm.), available data from 1945 to 1963 from the Campbellton station were selected as representative of the average climate conditions in the Assessment Area for the pre-dam time period.

A summary of the climate averages and extremes for the Town of Campbellton, New Brunswick, for pre-dam conditions, is presented in Table 3.3.1. These normals are based on available data for the time period, and are limited to temperature and precipitation measurements.

Table 3.3.1 Campbellton Monthly Climate Normals (1945-1963) and Extremes

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature													
Monthly Mean (°C)	-10.9	-10.2	-4.4	2.5	9.3	15.1	19.0	17.7	13.0	7.1	0.7	-7.4	4.3
Monthly Maximum (°C)	-6.2	-4.9	0.7	7.0	14.6	20.6	24.6	23.4	18.2	11.4	3.8	-3.6	9.1
Monthly Minimum (°C)	-15.7	-15.5	-9.3	-1.9	4.0	9.6	13.4	12.1	7.7	2.7	-2.4	-11.3	-0.6
Extreme Monthly Maximum (°C)	-1.0	-1.1	4.2	10.1	18.4	22.6	27.6	26.3	22.2	15.1	6.5	0.4	--
Date (yr)	1956	1960	1958	1951	1950	1949	1952	1945	1945	1946	1950	1950	--
Extreme Monthly Minimum (°C)	-22.4	-21.4	-13.8	-6.4	1.9	7.8	11.0	10.3	4.6	1.1	-4.7	-17.1	--
Date (yr)	1957	1948	1963	1947	1956	1958	1946	1956	1963	1948	1949	1958	--
Precipitation													
Rainfall (mm)	14.1	5.4	13.9	39.1	76.4	93.9	97.6	88.0	83.4	62.0	74.6	20.8	669.2
Snowfall (cm)	80.9	84.6	70.7	24.4	1.8	0.0	0.0	0.0	0.0	5.8	27.4	65.7	361.2
Total Precipitation (mm)	95.0	89.8	84.6	63.5	78.2	93.9	97.6	88.0	83.4	67.8	102.1	86.5	1030.4

Source: (Environment Canada, 2004a)
-- = Not available

Although the climate data from the Campbellton meteorological station may be representative of general weather conditions in the region during the pre-dam period, there may still be some variation between the data presented in Table 3.3.1, and the actual climate conditions in the Assessment Area. The Assessment Area is expected to be influenced to a greater extent by Chaleur Bay, which may lead to slightly cooler summer temperatures than those measured at the Campbellton station. However, given the proximity of the Campbellton site to the Assessment Area, and its location along the northern Restigouche County coastline, these variations are expected to be nominal.

No useful data on greenhouse gas (GHG) emissions could be located for pre-dam conditions. Therefore, GHG emissions in the Assessment Area during the pre-dam period could not be characterized quantitatively. However, given the rural environment of the Assessment Area, and the relatively unchanged population and industrial base in the Eel River region over the years (CIIRD, 1996), GHG emissions during the pre-dam period are not expected to be markedly different than existing levels.

3.3.1.2 Post-dam and Existing Conditions

The general climate trends and influences in northern New Brunswick, including the Assessment Area, are long-term characteristics and as such are not expected to change for pre-dam and existing conditions. In this regard, the discussion of climate and weather trends for the pre-dam time period is equally applicable for the characterization of climate for existing conditions.

Available climate data from the Charlo Airport meteorological station, first established in 1966, were selected as representative of the average climate conditions in the Assessment Area for the characterization of existing conditions. A summary of the data, in the form of climate normals and weather extremes for 1971-2000, is presented in Table 3.3.2.

A wind rose plot presenting the annual average joint frequency distribution of wind speed and direction for the Charlo Airport weather station (1994 to 1997) is presented in Figure 3.3.1. The wind direction is reported as the direction from which the wind blows. The most recent year of complete wind statistics from the Charlo weather station upon which to base a wind rose plot is the year 1997.

As illustrated in Figure 3.3.1, there is a substantive east-west character in the winds in the Assessment Area. This is largely a result of prevailing winds from the west and southwest, storm systems from the east and the influence of the local topography along the coast on the flow of these air masses as they pass over the land and water.

As shown, the dominant winds are from the west, south-southwest, northwest, and east. Winds occur less frequently from the southeast and north. Strong winds are most likely to blow from the western quadrant and the easterly direction.

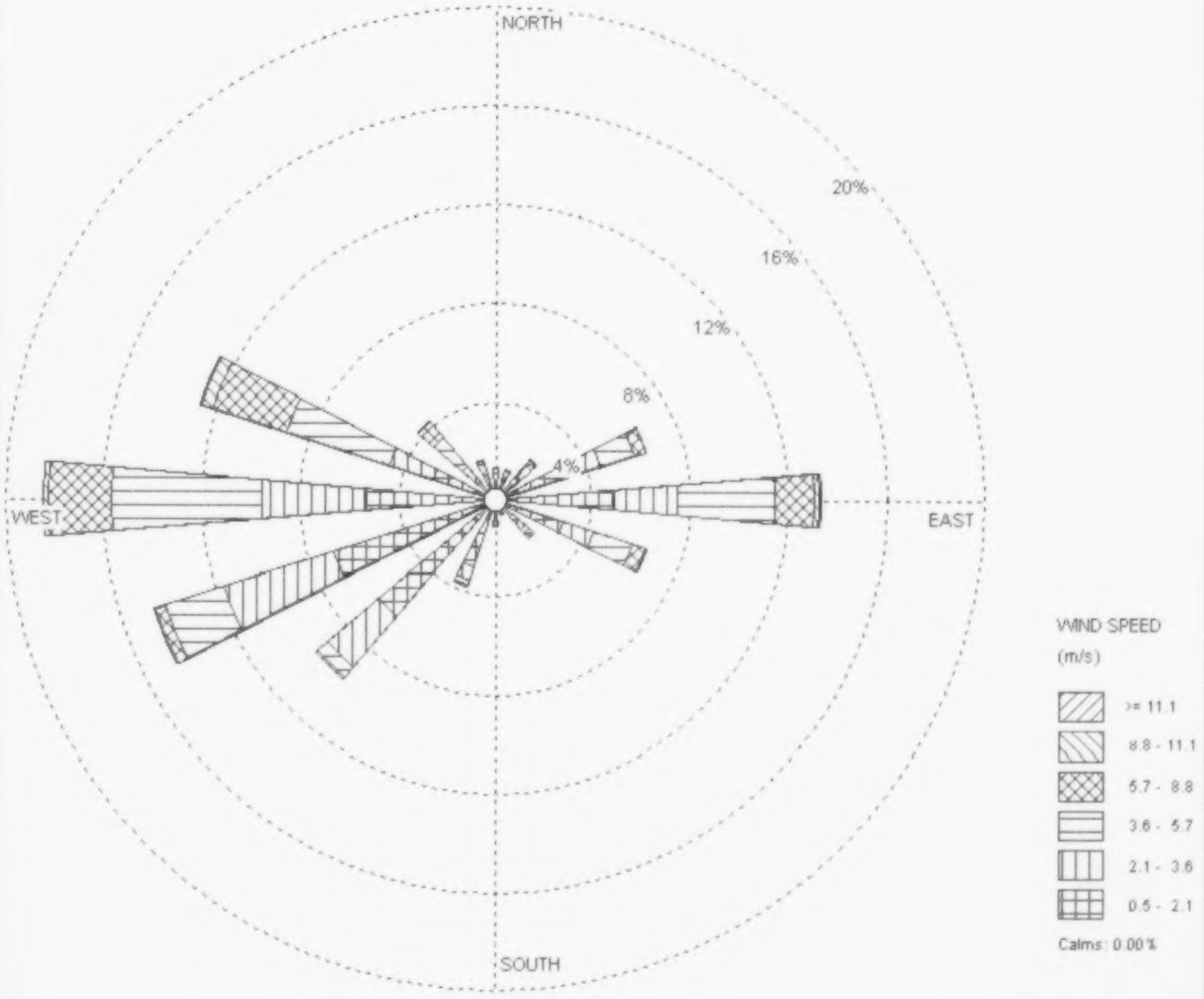
There are limited specific data available with regard to GHG emissions in the Assessment Area. The emissions of GHG in the Assessment Area were therefore estimated based on the most recent published data from national GHG inventories, such as *Canada's Greenhouse Gas Inventory 1990-2002* (Environment Canada, 2003a), and *Canada's Emissions Outlook* (1996-2020) (Natural Resources Canada, 1999).

GHG in the above inventories are tabulated on a national and provincial/territorial scale (rather than on a local scale). Therefore, local emissions were estimated by interpolating the provincial emissions data, based on the population ratios for the Province and the Assessment Area. For the purposes of emissions estimation, the Assessment Area was extended to include the entire Restigouche County region, to provide for a more representative approximation by incorporating the main population and industrial centers along the County coastline in the vicinity of the Eel River area. It should be noted that since specific GHG emissions data were not available for the Assessment Area, these emissions estimates should only be considered as approximations intended for comparison purposes.

Table 3.3.2 Charlo Airport Monthly Climate Normals (1971-2000) and Extremes

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Daily Mean (°C)	-12.8	-11.1	-5.1	1.6	8.6	14.7	17.9	16.8	11.6	5.5	-0.9	-8.6	3.2
Daily Maximum (°C)	-7.7	-5.7	0.0	6.1	14.5	20.6	23.4	22.4	17.0	10.0	2.7	-4.3	8.3
Daily Minimum (°C)	-17.9	-16.4	-10.1	-2.9	2.7	8.7	12.2	11.2	6.1	0.9	-4.5	-13.0	-1.9
Extreme Daily Maximum (°C)	11.7	14.4	17.8	28.8	33.4	34.8	35.2	34.4	32.3	24.3	19.4	12.2	--
Date (yr/day)	1996/19	1981/12	1987/25	1987/21	1977/23	1983/22	1983/05	1975/02	2001/09	1996/02	1977/03	1966/11	--
Extreme Daily Minimum (°C)	-36.5	-32.2	-30.1	-20.3	-8.3	-1.6	3.3	-0.1	-3.3	-9.4	-20.6	-31.7	--
Date (yr/day)	1984/22	1990/27	2001/02	1994/02	1972/02	1990/01	1969/07	1986/07	1986/30	1971/28	1976/30	1971/20	--
Precipitation													
Rainfall (mm)	14.4	6.9	22.1	47.6	82.9	85.3	102.3	94.9	84.6	85.5	56.0	25.8	708.2
Snowfall (cm)	90.2	69.9	71.1	36.0	3.2	0.0	0.0	0.0	0.0	3.4	37.3	80.9	392.0
Precipitation (mm)	91.9	65.2	87.3	82.0	86.4	85.6	102.3	94.9	84.6	88.9	90.0	95.0	1054.0
Extreme Daily Precipitation (mm)	42.2	41.2	62.8	96.6	40.4	40.0	113.2	68.8	97.8	66.8	62.4	58.2	--
Date (yr/day)	1998/24	2001/06	1981/17	1980/23	1970/06	1977/07	2001/11	1970/12	1999/07	1990/24	1983/25	1987/01	--
Days With													
Maximum Temperature > 0°C	4.0	5.0	16.4	27.4	31.0	30.0	31.0	31.0	30.0	30.9	21.4	7.9	265.9
Measurable Rainfall	2.8	1.9	4.6	9.4	13.9	13.4	14.7	13.5	12.4	13.7	8.6	3.9	112.8
Measurable Snowfall	14.2	10.9	10.8	6.5	0.8	0.0	0.0	0.0	0.0	0.97	7.5	13.9	65.5
Measurable Precipitation	14.5	11.2	13.0	13.4	14.1	13.4	14.7	13.5	12.4	14.1	13.6	14.8	162.6
Fog* days	3	2	5	5	6	5	5	5	4	5	4	3	52
Thunderstorms** days	0	0	0	0	1	3	5	4	1	0	0	0	14
Other													
Sunshine (hrs)	117.8	135.1	152.2	164.6	216.6	239.2	252.9	242.5	165.0	130.8	92.1	63.3	2005.1
Daytime Relative Humidity (%)	68.3	65.5	64.1	62.5	58.2	59.3	62.1	61.8	63.5	64.2	71.4	72.1	64.4
Mean Wind Speed (km/h)	16.3	16.3	15.8	14.8	13.9	12.7	11.6	11.4	12.4	13.3	14.9	15.7	14.1
Most Frequent Wind Direction	W	W	W	E	E	E	W	W	W	W	W	W	--
Extreme Wind Gust Speed (km/h)	109.0	129.0	122.0	119.0	90.0	89.0	98.0	93.0	97.0	93.0	100.0	108.0	--
Date (yr/day)	1972/25	1972/17	1971/04	1970/03	1972/23	1986/18	1985/26	1983/21	1971/24	1979/06	1972/29	1972/02	--

Source: (Environment Canada, 2004b)
* Data from 1966-1980
** Data from 1967-1990



Wind Speed and Wind Direction Annual Average Joint Frequency Distribution – Charlo Airport (1994-1997)

Date:
03/31/2006

Scale:

Job No.
15830

Figure No.
3.3.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT
Brunswick

NBDSS PROJECT No. YR101A

The population ratios were established using the most recent data from the 2001 Census and published projection factors (Government of New Brunswick, 2004), and are presented in Table 3.3.3.

Table 3.3.3 New Brunswick and Assessment Area Population Counts by Census Year

Census Year	New Brunswick Population	Population for the Assessment Area (Restigouche County)
2001[1]	729,500	36,134
2005 (projected)[2]	732,420	34,835

[1] Population Counts, New Brunswick Census Subdivisions 2001 (Government of New Brunswick, 2004).

[2] Based on recent projected population growth rates of +0.1%/year for the province, and –0.9%/year for Restigouche County (Government of New Brunswick, 2004).

The estimated emissions of GHG in the Assessment Area are provided in Table 3.3.4. It should be noted that data from the Environment Canada national inventories incorporated GHG emissions for all industrial, commercial, and domestic sectors, including transportation sources. Therefore, these data are not intended to represent the approximate contributions from an individual source or group of sources, but rather from the total emissions sources in a particular geographical region.

Table 3.3.4 Greenhouse Gas Emissions – Existing (2005) Estimates

Region	Estimated Greenhouse Gas Emissions (tonnes CO2-equivalents/year)
New Brunswick Provincial Emissions[2]	23,700,000
Local Emissions for Assessment Area[1,2] (Restigouche County)	1,127,200

[1] Based on population estimates from Census data and projections (Government of New Brunswick, 2004). Assessment Area is Restigouche County.

[2] Environment Canada GHG Inventory, 1990-2002 (Environment Canada, 2003a). Emissions for 2005 estimated using a provincial GHG increase of 1.1%/year, Canada's Emissions Outlook, 1996-2020 (Natural Resources Canada, 1999)

It is conventional to report GHG emissions as CO_2-equivalents, as evident in Table 3.3.4, whereby the emissions of each of the GHG are reported as CO_2 by multiplying the emission rate of each compound by their global warming potential (GWP) relative to CO_2 ($CO_2 = 1.0$, $CH_4 = 21.0$, and $N_2O = 310.0$).

3.3.2 Air Quality

Air quality is a broad term that generally refers to the properties and characteristics of the air in the lower atmosphere in a given area. Air quality is typically characterized by knowledge of air contaminant emissions from point and area sources in a specific location, as well as knowledge of the existing ground-level concentrations of contaminants of interest in the outdoor air (termed "ambient air quality").

A discussion of air quality in the Assessment Area is provided in the following sections for pre-dam and existing conditions.

3.3.2.1 Pre-dam Conditions

Air quality issues generally received little attention by government agencies and the general public in North America until the early 1970s. As a result, no useful source of quantitative information related to air contaminant emissions or the quality of ambient air in the Assessment Area and surrounding region could be located for the pre-dam time period. In the absence of such data, the air quality in the Assessment Area for pre-dam conditions could not be characterized quantitatively, and is therefore addressed qualitatively based on the historical demographics and development of the region.

The Assessment Area is a predominantly rural environment with small population centers in the nearby communities of the Village of Eel River Crossing, Village of Charlo and the Town of Dalhousie. The population of the Restigouche County, including the Eel River area, during pre-dam conditions would have been on the order of 40,000 (CIRRD, 1996), which has remained relatively unchanged when compared with the 2001 Census estimate of approximately 36,134 (Government of New Brunswick, 2004). Although local industrial and commercial development has increased from the pre-dam period, given the relatively unchanged population and urban growth, this has not markedly affected the rural characteristics of the Assessment Area.

Natural sources of emissions in the Assessment Area during the pre-dam time period likely included wind blown dust, road dust, and emissions from domestic heating systems. Since local roadway projects such as the Route 134 and Highway 11 crossings were constructed during or following dam installation, it is likely that few roads in the area would have been paved. However, since there were fewer vehicles travelling on the local roadways during the pre-dam period, it is unlikely that the combined emissions from roadway use would have varied substantially from current levels. Domestic heating appliances, such as woodstoves, would have been more common during pre-dam conditions prior to emergence of electrical heating in the 1970s. However, there is little evidence to suggest that these emissions would have been markedly different from current levels.

Although it cannot be scientifically or numerically confirmed, given the relative little change in population and industrial emission sources, it is likely that air contaminant emissions and ambient air quality in the Assessment Area during pre-dam conditions would have been similar to existing air quality conditions.

3.3.2.2 Post-dam and Existing Conditions

The existing air quality in the Assessment Area will be characterized based on the existing conventional air contaminant emissions in the area and the ambient ground-level concentrations of these contaminants. The air contaminants of interest include total particulate matter (TPM) (including dust), sulphur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO).

There is limited information available with regard to the existing emissions of the selected air contaminants in the Assessment Area. Although some summary information for air contaminant emissions in the region is available from the NBENV, as well as the Environment Canada National Pollutant Release Inventory (NPRI), these emissions are only tabulated for a limited number of specific industrial sources, and do not include contributions from non-point sources (*e.g.*, windblown dust, vehicle emissions, and domestic heating systems).

Given these constraints, the existing emissions of the selected air contaminants were estimated based on the latest available published data from the Pollution Data Branch of Environment Canada, including the Environment Canada 1995 Criteria Air Contaminant Emissions for Canada inventory (Environment Canada, 1999), and the Consensus Forecasts for Criteria Air Contaminants 1990-2010 (SO_2 and NO_X only) (Environment Canada, 2003b).

Air contaminant emissions in the above inventories are tabulated on a national and provincial/territorial scale (rather than on a local scale). Therefore, similar to the greenhouse gas emissions estimates, the air contaminant emissions were estimated by interpolating the Provincial emissions data, based on the population ratios, as presented in Table 3.3.5, for the Province and the Assessment Area. For the purposes of emissions estimation, the Assessment Area was extended to include the entire Restigouche County region, to provide for a more representative approximation by incorporating the main population and industrial centres along the County coastline in the vicinity of the Eel River area. Since specific air contaminant emissions data were not available for the Assessment Area, these emissions estimates should only be considered as approximations intended for comparison purposes.

The estimated emissions of selected air contaminants in the Assessment Area are provided in Table 3.3.5. It should be noted that data from the Environment Canada national inventories incorporated air contaminant emissions for all industrial, commercial, and domestic sectors including transportation sources. Therefore, these data are not intended to represent the approximate contributions from an individual source or group of sources, but rather from the total emissions sources in a particular geographical region.

Table 3.3.5 Air Contaminant Emissions – Estimates for the Assessment Area for Existing (2005) Conditions

Parameter	New Brunswick Provincial Emissions (tonnes/year)	Estimated Emissions from the Assessment Area *(Restigouche County)* (tonnes/year)[3]
Total Particulate Matter (TPM)[1]	454,266	22,450
Sulphur Oxides (SO_X as SO_2)[2,3]	175,000	8,325
Nitrogen Oxides (NO_X as NO_2)[2,3]	68,000	3,235
Carbon Monoxide (CO)[1]	324,025	16,015

[1] Environment Canada 1995 emissions inventory (Environment Canada, 1999).
[2] Environment Canada Consensus Forecasts 1990-2010 (Environment Canada, 2003b).
[3] Based on population estimates and projections from census data. See Table 3.3.3 (Government of New Brunswick, 2004).

Due to the limited availability of specific emissions data for the Assessment Area, and since available national projections for 2005 are limited to SO_2 and NO_X, the emissions of TPM, and CO could not be estimated for existing (2005) conditions. Therefore, the emissions presented in Table 3.3.5 for these contaminants are inventory estimates from 1995 (Environment Canada, 1999). However, since there has been relatively little improvement in industrial and vehicle emission control technologies and limited implementation of regulatory emission standards for these parameters, these emissions are not expected to be markedly different for current (2005) conditions.

Ambient air quality conditions are typically assessed in terms of the historical measured levels of contaminants at ground-level in a particular area, compared to the Maximum Permissible Ground-Level Concentrations of contaminants as established in the New Brunswick Air Quality Regulation under the *Clean Air Act* (Government of New Brunswick, 1997). The New Brunswick Maximum Permissible Ground-Level Concentrations are presented in Table 3.3.6 for reference and for comparison with measured data. The federal National Ambient Air Quality Objectives (Government of Canada, 1999) maximum desirable and acceptable levels, above which immediate action should be taken to protect air quality, are also provided for comparison.

Table 3.3.6 Canadian and New Brunswick Ambient Air Quality Objectives for Selected Air Contaminants

Contaminant	Averaging Period	New Brunswick Maximum Permissible Ground-Level Concentrations[1] (µg/m^3)	National Ambient Air Quality Objectives, Maximum Desirable/Acceptable Levels[2] (µg/m^3)
Carbon Monoxide (CO)	1-hr 8-hr	35,000 15,000	-- --
Sulphur Dioxide (SO_2)	1-hr 24-hr Annual	900 300 60	450 / 900 150 / 300 30 / 60
Nitrogen Oxides (NO_X as NO_2)	1-hr 24-hr Annual	400 200 100	- / 400 60 / 100
Total Suspended Particulate Matter (TSP)	24-hr Annual	120 70	- / 120 60 / 70

[1] Schedule B – Maximum Permissible Ground-Level Concentrations in Micrograms per Cubic Metre at Standard Conditions of 21°C and 101.3 kPa (Government of New Brunswick, 1997)

[2] Government of Canada (1999).

There are currently six ambient air quality monitoring sites in operation in the Assessment Area, all of which are operated by NB Power. Although the standards and objectives presented in Table 3.3.6 are for all the selected air contaminants, the monitoring sites in the Assessment Area measure only SO_2 and TSP. A total of five monitoring sites are in operation in and around the Town of Dalhousie, with one site located in the Village of Charlo. SO_2 is monitored at these five sites, one of which also measures TPM. TPM is monitored independently at one additional site.

A summary of the results from the ambient air quality monitoring sites in the Assessment Area, from 1998-2003, is presented in Table 3.3.7. More detailed information on these results may be found in the annual publication by the NBENV (NBDELG, 2000; 2002; 2003; 2004a; 2004b) and the New Brunswick Department of the Environment in previous years (NBDOE, 1999).

Table 3.3.7 Summary of Ambient Air Quality Monitoring Data (1998-2003)

Station Name	Parameter	1998	1999	2000	2001	2002	2003
NB Power Dalhousie – Bayview	SO_2 – Annual Average Concentration (µg/m^3)	--	4.5	0.0	0.0	0.0	0.0
NB Power Dalhousie – Tower	SO_2 – Annual Average Concentration (µg/m^3)	2.6	4.5	0.0	0.0	0.0	0.0
	TSP – Annual Average Concentration (µg/m^3)	<30	<25	<25	<10	<10	<10
NB Power Dalhousie – Mobile	SO_2 – Annual Average Concentration (µg/m^3)	6.0	4.5	0.0	0.0	0.0	0.0
NB Power Dalhousie – Point La Nim	SO_2 – Annual Average Concentration (µg/m^3)	5.0	3.7	0.0	0.0	0.0	0.0
NB Power Dalhousie – Coal Berm	TSP – Annual Average Concentration (µg/m^3)	<30	<25	<25	<10	<10	<10
NB Power Dalhousie – Charlo	SO_2 – Annual Average Concentration (µg/m^3)	3.7	2.9	0.0	0.0	0.0	0.0
NB Power Dalhousie – High School	SO_2 – Annual Average Concentration (µg/m^3)	3.9	--	--	--	--	--

--Data not available. Monitoring site not in operation.

Ground-level concentrations of SO_2 and TSP were notably low in the Assessment Area for the entirety of the selected monitoring period (1998-2003). The monitored concentrations have also shown a decreasing trend over recent years, culminating in non-detectable annual average concentrations for SO_2 and concentrations of <10 µg/m^3 for TSP at all sites. Compliance with the applicable 1-hour, 24-hour and annual ambient air quality standards, as presented in Table 3.3.6, was 100 percent, with no exceedences of these standards reported for any monitoring year.

Based on the notably low monitored ground-level concentrations of SO_2 and TSP, and their complete compliance with applicable national and provincial ambient air quality standards, it can be concluded that the existing ambient air quality in the Assessment Area is very good.

3.3.3 Sound Quality

Sound quality generally refers to the type, intensity, and character of sound in the outdoor environment. Sound quality in the outdoor environment can be influenced by a variety of natural and anthropogenic (human-made) factors. Natural factors which may influence the sound quality of the outdoor environment include sound such as that associated with wind movement through vegetation, waves in water colliding against shorelines, and sounds produced by birds and other animals. Some anthropogenic factors that may influence sound quality include sound emissions from stationary and mobile sources such as the operation of construction equipment, industrial sources, and vehicle traffic. Changes to the physical environment (such as a change in land cover or the removal of trees) can also result in changes to sound propagation characteristics in the area.

It should be noted that since sound quality and emissions are localized in nature when compared to climate and air quality parameters, the Assessment Area, for the purposes of sound quality characterization, is limited to a distance of approximately 100 m on each side of the river from the Eel River bar to the Highway 11 Bridge.

3.3.3.1 Pre-dam Conditions

No published data on sound quality in the Assessment Area could be located for pre-dam conditions. In the absence of such data, the sound quality in the Assessment Area for pre-dam conditions could not be characterized quantitatively, and is therefore addressed qualitatively based on the historical demographics and development of the region.

The Eel River region represents a predominantly rural environment with a small population base concentrated in the nearby Town of Dalhousie and Villages of Charlo and Eel River Crossing. The population and industrial development in the region has changed relatively little from the pre-dam to existing time frames (CIIRD, 1996). Based on historical aerial photographs, there was very little local residential or commercial development around the Eel River shorelines during the pre-dam time period.

The likely existing dominant source of noise emissions in the vicinity of the Eel River and current dam structure (as will be discussed further in the existing conditions section), is vehicle traffic in the local area and on the Route 134 and Highway 11 crossings. Since these projects were completed during or following dam installation, local vehicle traffic during the pre-dam period is expected to have been very nominal, thereby likely resulting in few sound quality issues.

Given these factors, and the rural environment of the region, local noise levels are expected to have been similar to or lower than existing levels, and characteristic of a rural environment.

3.3.3.2 Post-dam and Existing Conditions

No published data with regard to sound quality in the Assessment Area could be located to establish existing conditions. In the absence of such data, the sound quality in the Assessment Area for existing conditions could not be characterized quantitatively, and is therefore addressed qualitatively.

Based on recent aerial photographs, the local sources of potential noise emissions may include the residential development on the north shore of the estuary below the dam, and vehicle traffic on the Route 134 and Highway 11 crossings, and along the south shore of the river in the vicinity of the dam (due to visitors to the Aboriginal Heritage Site and Blue Heron Campground). It is expected that vehicle traffic on the river crossings, as a result of these developments, would represent the dominant source of local noise emissions.

However, given the lower traffic levels on these crossings (due to the lower regional population) when compared with other major traffic routes in the Province, and the topographical features of the area (such as rolling terrain and abundant tree cover) the existing local noise levels are expected to be relatively low and characteristic of a rural environment.

Other topographical features of the area include the impoundment created following dam construction. This water body represents a large reflective surface, which may result in the sound emissions in the area upstream of the dam to be transmitted further across the river than during the pre-dam period. However, since the existing water levels in the estuary below the dam are similar to those during the pre-dam period, the existing sound propagation characteristics in this area are expected to have changed little from pre-dam conditions.

3.3.4 Odour

Odour is the characteristic of a substance that makes it perceptible to the sense of smell. Most odours are combinations of various chemicals that interact to generate what humans identify as an odour. Odour is a very subjective parameter, with the perception of the character, strength, and, therefore, frequency and location of a particular odour being variable from person to person. Odour emissions and their sources are therefore difficult to quantify, since there is no single parameter that can easily describe an odour nuisance. The odour emissions in a particular area can be influenced by a variety of factors, including the odour emission rate at the source, the surrounding land topography, the amount and type of nearby vegetation, as well as atmospheric conditions such as wind speed and direction. Anthropogenic sources which may affect odour emissions include motor vehicles and industrial and manufacturing processes.

Due to the localized nature of odour emissions, the Assessment Area, for the purposes of characterization of odour emissions, is limited to a distance of approximately 100 m on each side of the river from the Eel River bar to the Highway 11 Bridge. This also includes the area covered by the impoundment.

3.3.4.1 Pre-dam Conditions

No data, published or otherwise, for odour emissions in the Assessment Area could be located for pre-dam conditions. In the absence of data, and due to the subjective nature of odour perception and detection, the odour emissions in the Assessment Area could not be characterized quantitatively or qualitatively for pre-dam conditions.

3.3.4.2 Post-dam and Existing Conditions

No published data with regard to odour emissions in the Assessment Area could be located for existing conditions. However, the existing conditions with respect to odour emissions are expected to be typical of an estuarine environment near marine waters. No odour emissions were reported by any members of the Water Quality Field Study Team during any of the fieldwork conducted in the impoundment area, including during the period of low water level in the impoundment in August 2005. One resident of the Village of Eel River Crossing, whose house is situated along Eel River near the former sewage lagoon outfall, reported an unpleasant odour occurring on a regular basis near their property. Since the Village of Eel River Crossing was connected to the Town of Dalhousie sewage treatment system in June 2005, the resident has reported an improvement in the odour.

The small amount of submerged vegetation present in the impoundment does not seem to be great enough to cause the substantive negative odour emissions that result from the decomposition of organic matter. The potential for odour issues arising from increased nutrient loadings has been greatly reduced by the deactivation of the former sewage lagoon outfall.

Low water level in the impoundment in August 2005 exposed much of the bottom. The Field Study Team noted that the bottom is largely composed of sandy, silty or clay sediment, which does not tend to have an odour, unlike organic rich beds which tend to have a characteristic mud-flat like odour.

Current levels of submerged vegetation and nutrient loadings, along with the type of sediment at the bottom of the impoundment, do not seem to be causing any appreciable odour emissions.

3.4 Fish Habitat and Fish

3.4.1 Water Quality

The water quality considerations that will be given greatest weight in this environmental assessment include:

- nutrients (phosphorus and nitrogen) that can alter biological communities through the process of eutrophication;
- biochemical oxygen demand (BOD), which can alter biological communities if oxygen concentrations in the receiving environment become limiting for aquatic life;
- temperature, which can be limiting for aquatic life if it is too high; and
- salinity, which is an important determinant of the kinds of aquatic life that can exist, and which can be limiting to migrating fish if salinity gradients are too abrupt.

The presence and numbers of coliform bacteria in water (total and/or fecal coliforms) are considered within Section 3.15.2, since these bacteria are primarily of concern to human health. The Eel River watershed contains several landfills (municipal and industrial) that could potentially release contaminants to the Eel River. These landfills are monitored by their owners under the regulatory authority of the NBENV, and it is assumed that contaminants (such as heavy metals or persistent organic pollutants) that could be released from these facilities are under regulatory surveillance and control at the source. Since these substances have a strong tendency to bind to and remain stored in sediments, whereas concentrations in water would be more transient, greater consideration of industrial pollutants is provided in the review of sediment quality (Section 3.4.2). However, it is important to note at this point that despite a published expression of concern about trace metal contaminants (notably copper, mercury and zinc) in the water of the Eel River impoundment (BMA and CG&S, 2000), the supporting document (CH2M, 1998) contains errors in data and interpretation. There is no reason to believe that the water of the Eel River impoundment was historically contaminated by industrial sources, or that historical trace metal concentrations in the water have been at levels that would pose a risk to human health, or to populations of fish or wildlife.

3.4.1.1 Pre-dam Conditions

Water quality information is limited for the Eel River, prior to construction of the Eel River dam in 1963. However the New Brunswick Water Authority conducted water sampling at a freshwater site by the covered bridge in Eel River Crossing in May 1962. The Eel River water was deemed to be "soft water, low in suspended matter and dissolved organic matter" (NBWA, 1962), as would be expected for a relatively undeveloped catchment in northern New Brunswick. A summary of the 1962 water quality sampling results is provided in Table 3.4.1 (DMTS, 1962).

The Villages of Balmoral and Eel River Crossing did not have wastewater treatment ponds prior to the construction of the Eel River dam. The Village of Balmoral's wastewater treatment pond started operation in 1981. The Village of Eel River Crossing's wastewater treatment pond started operation in 1975. The operation of the wastewater treatment in these two villages may have reduced contaminant loadings into the Eel River compared to the period prior to the construction of the dam. However, both villages have experienced moderate population growth since the construction of the Eel River dam, which may have offset, to some extent, the anticipated reduction in contaminant loadings into Eel River afforded by the operation of the wastewater treatment ponds.

There is no evidence of excessive algal growth (in the area that is presently impounded) in the historical aerial photographs prior to the construction of the dam, indicating a relatively low level of nutrient availability prior to the construction of the dam. There are no data indicating BOD, dissolved oxygen, and nutrient concentrations in the presently impounded area prior to construction of the Eel River dam. However, given the land use and tidal prism, it is likely that concentrations of BOD and nutrients in freshwater entering the estuary would have been generally low (*i.e.*, total phosphorus 0.005 mg/L or less; total nitrogen 0.5 mg/L or less). In addition, tidal flushing with marine waters from Chaleur Bay would likely have provided dilution and enhanced the removal of nutrients from the presently impounded area. Both of these factors would mitigate against eutrophication prior to the impoundment.

Table 3.4.1 Water Quality Sampling Results at Eel River Crossing (May 17, 1962)

Parameter Analyzed	Result (mg/kg or ppm*)
pH	7.2
Colour (Hazen units)	25
Turbidity	0
Alkalinity (as $CaCO_3$)	25.8
Hardness (as $CaCO_3$)	59.2
Conductivity	124
Calcium	21.4
Magnesium	1.4
Iron (total)	0.10
Aluminum	0.0
Manganese (total)	Trace
Copper	Trace
Zinc	Trace
Nitrite	0.0
Ammonia	0.1
Carbonate	0.0

Table 3.4.1 Water Quality Sampling Results at Eel River Crossing (May 17, 1962)

Parameter Analyzed	Result (mg/kg or ppm*)
Bicarbonate	64.4
Sulphate	6.6
Chloride	2.9
Fluoride	0.9
Phosphate (Total: Dissolved)	0.09:0.07
Nitrate	0.7
Silica	4.4
% Sodium	7.4

Note: * Except for pH, conductivity, turbidity and % sodium

3.4.1.2 Post-dam and Existing Conditions

At the time that this EIA study was initiated, the point sources of BOD and nutrient loadings into Eel River included the Villages of Balmoral and Eel River Crossing wastewater treatment ponds. However, in June 2005, the sewage collected from the Village of Eel River Crossing was permanently diverted to the Town of Dalhousie wastewater treatment system. The sewage lagoon for the Village of Eel River Crossing has been decommissioned, and there is no longer sewage effluent discharge from the Village of Eel River Crossing into Eel River.

The Village of Balmoral wastewater treatment pond serves approximately 1,400 of the Village's 1,800 people. Effluent from the wastewater treatment pond discharges into the South Branch Eel River, which feeds into the Eel River immediately south (upstream) of the Village of Eel River Crossing. The Village of Balmoral is currently reviewing options to upgrade its wastewater treatment facility to accommodate population growth and economic expansion.

The operator of the Village of Balmoral wastewater treatment lagoon measures the effluent discharge over a weir at the outfall chamber on a daily basis. The annual average effluent discharge from the lagoon is approximately 500 m^3/day. The average BOD concentration in the effluent discharge as measured by the New Brunswick Department of Environment (NBENV) is 25 mg/L. This translates into a BOD loading rate into the Eel River of approximately 12.5 kg/day.

Effluent discharge from small municipal wastewater treatment ponds typically has total phosphorus concentrations of approximately 2.0 to 2.4 mg/L and total nitrogen concentration of 25 to 29 mg/L (NBDELG, 1984). Using these concentrations, the total phosphorus and nitrogen loadings into Eel River from the Balmoral wastewater treatment pond is estimated to be on the order of 1.2 kg/day (440 kg/year) and 15 kg/day (5,480 kg/year), respectively. However, the nutrient concentrations in the effluent from these ponds may be lower than typical values. Based on limited data provided by the NBENV for the Balmoral and Eel River Crossing ponds, total phosphorus concentrations appear to be in the range of 1 mg/L, and total nitrogen concentrations appear to be in the range of 10 mg/L. Using these values, the total phosphorus and total nitrogen loadings from the Balmoral pond would be approximately 183 kg/year and 1,825 kg/year, respectively. Loadings from the former Village of Eel River Crossing wastewater treatment plant would presumably have been similar (*i.e.,* total phosphorus loading between 180 and 440 kg/year, and total nitrogen loading between 1,800 and 5,500 kg/year).

A portion of the population in the Eel River watershed, including the community of Dundee, relies on private septic systems for disposal of domestic sewage (Theriault, pers. comm.). It is expected that domestic sewage disposed to septic tanks will eventually contribute nutrient loadings (but negligible BOD) to Eel River. The residences in the Eel River watershed are typically not located in the immediate vicinity of the watercourses, which will attenuate and delay nutrient loading presumable through soil and vegetative filtration.

There is small scale agriculture in the lower portion of the Eel River watershed. Agriculture operations are a common source of nutrient loading into natural water bodies. Nutrient loading rates from the septic fields and agriculture operations are affected by many factors and are difficult to quantify in the case of the Eel River watershed. However, these loadings would be included within the overall nutrient loadings associated with the stream flow, as outlined below.

The Eel River has a total watershed area of approximately 220 km^2 (2.2×10^8 m^2). With a maritime climate and assuming a mean annual runoff of approximately 0.75 m/year, the river has an expected total annual flow volume of approximately 1.65×10^8 m^3.

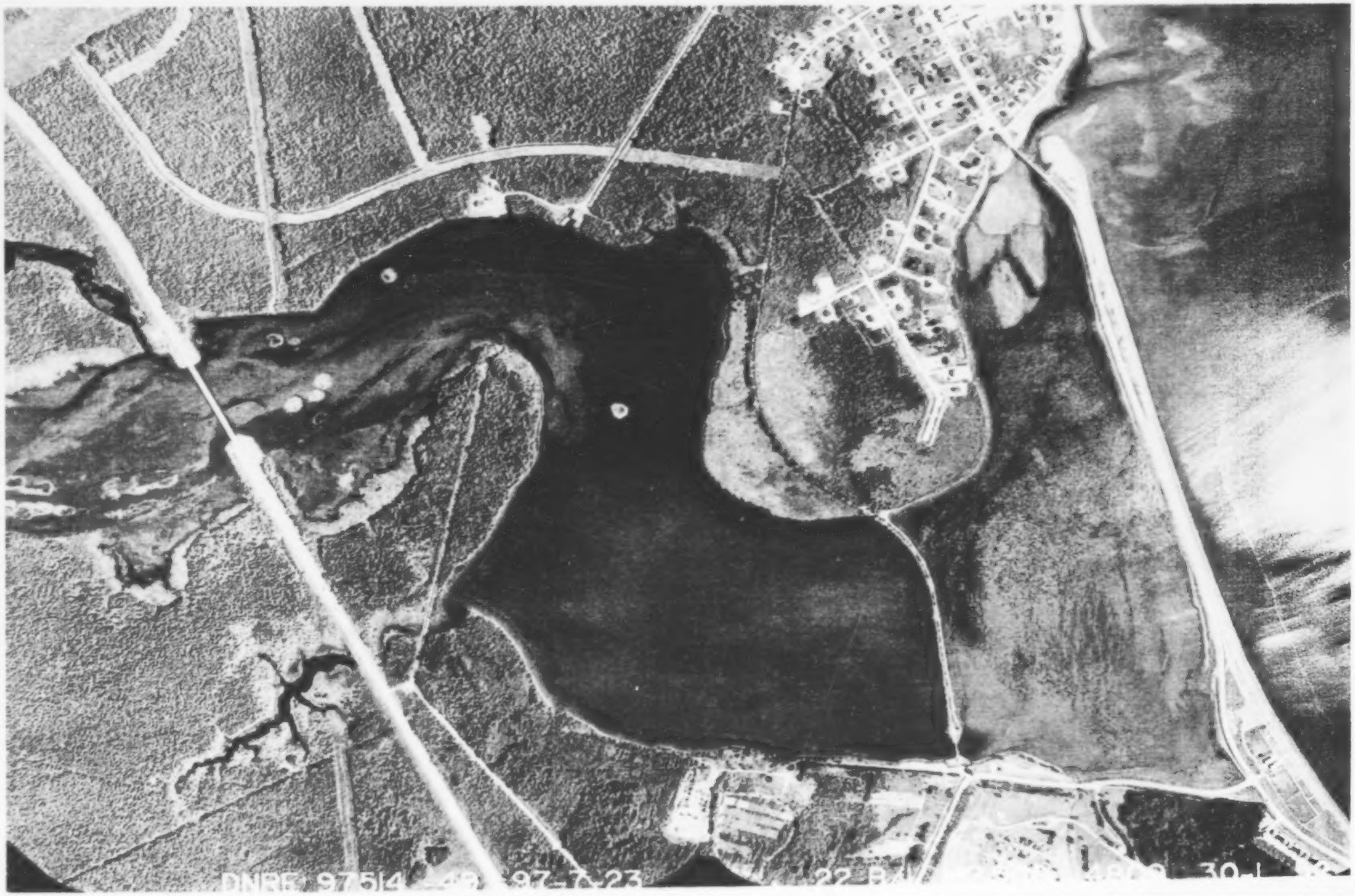
Water quality data collected by NBENV in 2004, for the Eel River watershed, can be used to estimate the nutrient export from the entire watershed. Station A10-1, situated lowest in the watershed, but upstream from the sewage effluent influence from the Village of Balmoral or Village of Eel River Crossing wastewater treatment ponds, provides an estimate of the nutrient concentrations in the river water, excluding the influence of the wastewater treatment plants. The mean concentrations for total phosphorus and total nitrogen were 0.01 mg/L, and 0.43 mg/L, respectively. Based upon the river flow of 1.65×10^8 m^3/year and the measured nutrient concentrations, the total annual phosphorus loading is approximately 1,650 kg/year, and the total annual nitrogen loading is approximately 70,950 kg/year (both estimates exclude past or present contributions from the wastewater treatment facilities).

The total phosphorus loading to the impoundment at the present time (*i.e.*, considering contributions from the overall watershed, as well as from the Village of Balmoral wastewater treatment plant) is therefore estimated to be around 2,000 kg/year, and the total nitrogen loading to the impoundment is estimated to be around 75,000 kg/year. The phosphorus loading from the Village of Balmoral represents about 15 to 20 percent of the total phosphorus loading to the impoundment, while the nitrogen loading represents about 2.5 to 8 percent of the total nitrogen loading to the impoundment. It is likely that the nutrient loadings from the Village of Eel River Crossing wastewater treatment pond would have been similar in magnitude to the loadings from the Village of Balmoral.

The upper portion of the impoundment is reported to have experienced gradual eutrophication since the construction of the Eel River dam. Evidence of eutrophication is provided by the algal growth that has been reported anecdotally by the Study Team and can be observed in recent aerial photographs (Figure 3.4.1). It is expected that this eutrophication is a result of net accumulation of nutrients in the impoundment due to lack of flushing. However, the shallow nature of much of the impoundment is a factor in the eutrophication process, since the entire water column as well as the sediments lie within the photic zone, where light levels will support algal growth. The shallow water is also prone to heating during the summer, and warm water temperatures also contribute to eutrophication by promoting biological activity. Once an algal mat forms on the surface of the sediments, oxygen concentrations and redox potentials at the sediment-water interface fall, leading to the release of soluble iron, manganese, and phosphorus from sediment to the overlying water, further increasing the eutrophic condition.

In a water quality study conducted on behalf of the Village of Eel River Crossing (Jacques Whitford, 2003), water samples were collected on November 5, 2003 from five locations in Eel River and one location at the sewage lagoon outfall re-entering the Eel River and analyzed for BOD. Of the five locations in Eel River, the most upstream station was approximately 10 km from the Village of Eel River Crossing and the station closest to the Village was approximately 4 km upriver. The water sample collected at the Village of Eel River Crossing sewage lagoon outfall showed a BOD concentration of 8 mg/L (this is lower than the typical BOD concentration (the typical BOD concentration in sewage lagoon outfall would be around 25 mg/L, NBENV data) in effluent as a result of the dilution by stream flow). The BOD concentration for the other samples at the five locations, which were collected upstream of the sewage outfall, all showed non-detectable BOD concentrations (*i.e.*, < 3 mg/L).

To help evaluate water quality concerns, water samples were collected in 2004 and 2005 and submitted for laboratory analysis. Water samples were collected either using a battery-operated water pump connected to a submersible hose with the intake placed at mid depth of the water column, or using a discrete water sampler (horizontal Alpha water sampler). Both of these techniques are widely used and considered to be reliable. The water samples were not filtered prior to analysis, but were submitted for "total" analysis. The performing laboratory, Research Productivity Council (RPC) in Fredericton, NB, would normally only filter a sample if it was specifically requested by their client, or if there was enough particulate matter to cause concern with respect to operation or contamination of their instruments. Normally, surface water or effluent samples that have low concentrations of suspended matter are not filtered prior to analysis (although groundwater samples that commonly contain noticeable amounts of suspended matter frequently are filtered). A modest amount of particulate matter will have little effect on the analytical results. The Eel River samples generally had Total Suspended Sediment (TSS) concentrations less than the detection limit of 5 mg/L. Downstream of the dam in the estuarine and marine environments, TSS was reported to be in the range of 10 to 46 mg/L. However, RPC stated in their analytical report that the analyses with higher values of TSS (*e.g.*, 46 mg/L) may have been artificially high as a result of the high concentrations of salt present.


DNRE 97514
97-7-23
22 B
30-L

A 1997 Aerial Photo Showing the Upper Portion of the Impoundment

Date: 03/31/2006

Scale:

Job No. 15830

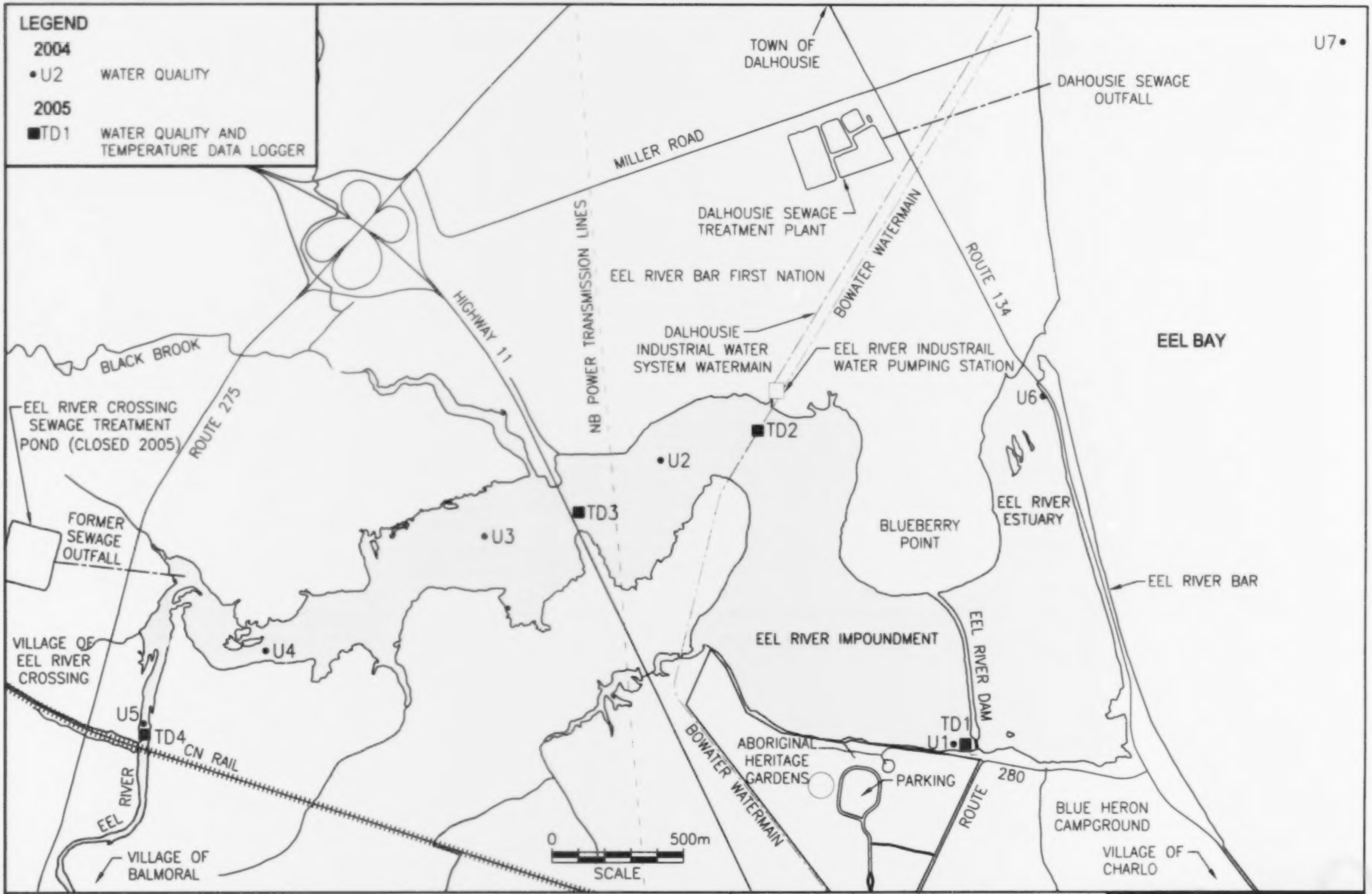
Figure No. 3.4.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

Brunswick

NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\WATER SAMPLING


LEGEND
2004
• U2 WATER QUALITY
2005
■ TD1 WATER QUALITY AND TEMPERATURE DATA LOGGER
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
U7
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
ROUTE 134
BOWATER WATERMAIN
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
HIGHWAY 11
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
EEL BAY
BLACK BROOK
ROUTE 275
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
U6
TD2
U2
TD3
U3
FORMER SEWAGE OUTFALL
BLUEBERRY POINT
EEL RIVER ESTUARY
EEL RIVER BAR
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
VILLAGE OF EEL RIVER CROSSING
U4
U5
TD4
CN RAIL
EEL RIVER
BOWATER WATERMAIN
ABORIGINAL HERITAGE GARDENS
PARKING
TD1
U1
ROUTE 280
BLUE HERON CAMPGROUND
VILLAGE OF CHARLO
VILLAGE OF BALMORAL
0
500m
SCALE

LOCATION OF WATER SAMPLING STATIONS IN 2004 AND 2005

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 3.4.2

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

Brunswick

NBDSS PROJECT No. YR101A

Table 3.4.2 General Water Quality Chemistry in the Eel River Area in 2004

Station	U1 (freshwater)	U1 (freshwater)	U3 (freshwater)	U3 (freshwater)	U6 (marine/estuarine)	U7 (marine)	U7 (marine)
Date Sampled	May 6/04	Aug 17/04	May 6/04	Aug. 17/04	Aug. 17/04	May 6/04	Aug. 17/04
Local Time Sampled	13:44	10:49	12:30	10:07	15:45	16:30	15:16
Tidal Stage					Rising (low)	Rising (high)	Rising (low)
Parameters Analyzed	**Concentration (mg/L)**						
Ammonia (as N)	0.05	< 0.05			< 0.05	< 0.05	< 0.05
Kjeldahl Nitrogen	0.35	0.65			0.45	< 0.25	0.60
pH (units)	7.8	8.4			8.3	7.4	8.2
Alkalinity (as $CaCO_3$)	49	97			92	102	92
Chloride	5.3	13.5			8200	8800	9620
Sulfate	6	5			1130	1240	1110
Nitrate + Nitrite (as N)	0.16	< 0.05			< 0.10	< 0.05	< 0.10
o-Phosphate (as P)	0.02	< 0.01			< 0.01	0.03	< 0.01
Total Phosphorus	0.105	0.033			0.027	0.051	0.036
r-Silica (as SiO_2)	4.2	2.8			2.6	2.2	2.4
Total Organic Carbon	6.9	7.3			1.0	1.2	1.4
Turbidity (NTU)	*	3.2			2.1	*	2.9
Total Suspended Sediments	< 5	5	< 5	< 5	34**	10	46**
Conductivity (µS/cm)	129	227			28900	29500	32200
Bicarbonate as $CaCO_3$	48.7	94.6			90.2	102.0	90.6
Carbonate as $CaCO_3$	0.29	2.23			1.69	0.24	1.35
Hydroxide as $CaCO_3$	0.032	0.126			0.100	0.013	0.079
Cation sum (meq/L)	1.33	2.39			240	261	273
Anion sum (meq/L)	1.27	2.42			257	276	296
Hardness (mg/L as $CaCO_3$)	56	100			2654	2879	2958
Ion Sum (mg/L)	72	128			14472	15622	16581

*Turbidity could not be determined due to the highly coloured nature of the samples

** Total Suspended Sediments analyses may have been affected by the very high concentrations of salt in the sample.

Table 3.4.3 Results of General Chemistry Analysis in the Water at Station TD1 (U1) in 2005.

General Chemistry	July 21			August 18			September 21		
	Sample 1 (freshwater)	**Sample 2 (freshwater)**	**Blank (Distilled water)**	**Sample 1 (freshwater)**	**Sample 2 (freshwater)**	**Blank (Distilled water)**	**Sample 1 (freshwater)**	**Sample 2 (freshwater)**	**Blank (Distilled water)**
Local Time Sampled	6:05	6:05	6:05	8:15	8:15	8:15	7:45	7:45	7:45
Tidal Stage	Ebbing	Ebbing	Ebbing	Ebbing	Ebbing	Ebbing	Ebbing	Ebbing	Ebbing
Parameters Analyzed	**Concentration (mg/L)**								
Ammonia (as N)	0.11	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.17	0.15	< 0.05
Kjeldahl Nitrogen	0.3	0.4	< 0.25	1	1.2	< 0.25	0.8	0.9	0.6
pH (units)	8.8	8.8	7.4	8	8	7.6	7.6	7.8	5.9
Alkalinity (as $CaCO_3$)	103	102	< 2	120	124	< 2	107	109	< 2
Chloride	155	179	< 0.5	1440	1440	< 0.5	305	315	< 0.5
Sulfate	24	30	< 1	194	155	< 1	41	41	< 1
Nitrate + Nitrite (as N)	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
o-Phosphate (as P)	0.03	0.02	< 0.01	0.03	0.03	< 0.01	0.02	0.02	< 0.01
Total Phosphorus	0.046	0.051	0.012	0.133	0.131	0.009	0.064	0.065	0.007
r-Silica (as SiO2)	2.1	2	< 0.1	0.6	0.6	< 0.1	4.0	3.9	< 0.1
Total Organic Carbon	5.9	5.9	< 0.5	5	5.1	0.6	8.4	8.3	0.6
Turbidity (NTU)	2.1	2.4	0.4	11.6	11.4	0.2	3.2	3.6	0.3
Total Suspended Sediments	< 5	< 5	< 5	20	22	< 5	12	9	< 5
Conductivity (µS/cm)	682	799	2	4540	4480	5	1120	1160	4
Bicarbonate as $CaCO_3$	96.9	96	-	119	123	-	107	108	-
Carbonate as $CaCO_3$	5.75	5.69	-	1.12	1.15	-	0.399	0.642	-
Hydroxide as $CaCO_3$	0.315	0.315	-	0.05	0.05	-	0.020	0.032	-
Cation sum (meq/L)	7.45	7.52	-	42.8	43.9	-	11.3	11.3	-
Anion sum (meq/L)	*6.93*	*7.71*	-	*47.1*	*46.3*	-	*11.6*	*11.9*	-
Hardness (mg/L as $CaCO_3$)	*156*	*154*	-	*518*	*527*	-	*176*	*177*	-

Water samples were collected in 2005 on three occasions (July 21, August 18, and September 21) at Station TD1 (U1) in the impoundment (Figure 3.4.2). Prior to these sampling events, the sewage effluent discharge from the Village of Eel River Crossing into the Eel River had stopped. These water samples were analyzed for general chemistry, including TKN and TP. The TP concentrations for these samples range from 46 µg/L in July 21 to 133 µg/L in August, and are comparable to those obtained in 2004. These TP concentrations indicate that the impoundment remained eutrophic in 2005, and that no immediate improvement in water quality was observed as a result of sewage diversion from the Village of Eel River Crossing. The results of the general water chemistry analyses for 2005 are provided in Table 3.4.3.

The results of the trace metal analyses conducted in 2004 are presented in Table 3.4.4. For parameters with a guideline identified in the CCME Environmental Quality Guidelines for the Protection of Aquatic Life (CCME, 2003a), iron and aluminum levels in the freshwater sample from Station U1 exceeded guidelines during the May sampling period. Arsenic levels in the marine samples at Stations U6 and U7 exceeded the guideline during the August sampling period. Shaded values in Table 3.4.4 indicate guideline exceedences. A high level of mercury observed in a sample from Site U1 is considered anomalous and it is believed that the sample was contaminated prior to analysis. Additional sampling for mercury was carried out during 2005, and this anomalous value was not repeated. The results of the trace metals analysis in water at station TD1 (U1) in 2005 are presented in Table 3.4.5.

In 2004, the dissolved oxygen (DO) concentration (as well as temperature and conductivity) was surveyed at all locations in the impoundment, the estuary below the dam and Eel Bay (Figure 3.4.2) on three occasions in May, June and August (Tables 3.4.2 and 3.4.6 and Figures 3.4.3 to 3.4.5). The temperature and conductivity measurements suggest that the impoundment was not significantly stratified, and that rapid wind-driven mixing of the water column is likely. The DO concentration was near saturation level on all occasions and at all locations, and differences between surface and bottom water DO concentrations were small (generally less than 1 mg/L). However, daytime DO concentrations can be augmented by oxygen released by photosynthetic algae and plants. These plants as well as other components of the aquatic community respire (consume oxygen) at night, and can cause depletion of DO concentrations. Therefore, additional sampling for DO was also carried out during 2005, with measurements being taken in the early morning (when any DO deficit caused by community respiration should be at its greatest, and before light intensity levels could support significant photosynthetic activity) and in the afternoon (when photosynthetic activity and enhancement of DO concentrations should be greatest).

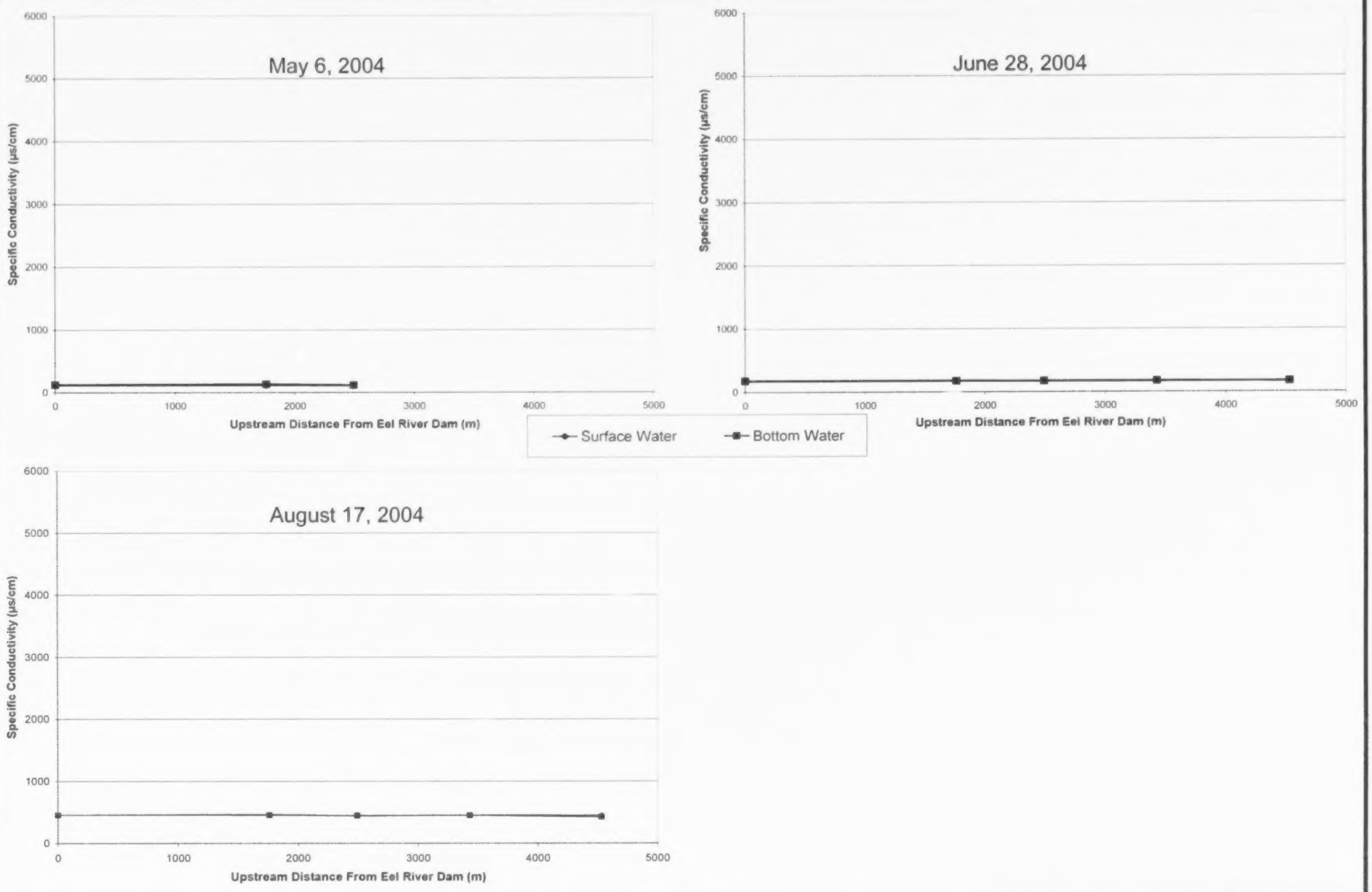
Table 3.4.4 **Trace Metals of Water Samples from the Eel River Area in 2004**

Station	CCME Guidelines Aquatic Life		U1 (freshwater)	U1 (freshwater)	U6 (marine/estuarine)	U7 (marine)	U7 (marine)
Date Sampled	Freshwater	Marine	May 6/04	Aug. 17/04	Aug. 17/04	May 6/04	Aug. 17/04
Tidal Stage					Rising (low)	Rising (high)	Rising (low)
Trace Metals	Concentration (µg/L)						
Aluminum	5-100	Ne	**144**	56	80	160	100
Antimony	Ne	Ne	< 0.1	< 0.1	< 1	< 2	< 1
Arsenic	5	12.5	< 1	< 1	**20**	< 20	**20**
Barium	Ne	Ne	14	24	10	< 20	10
Beryllium	Ne	Ne	0.1	< 0.1	< 1	< 2	< 1
Bismuth	Ne	Ne	< 1	< 1	< 10	< 20	< 10
Boron	Ne	Ne	10	10	1750	1770	1920
Cadmium	0.017	0.012	< 0.02	< 0.1	< 1	< 0.4	< 1
Calcium	Ne	Ne	19600	35000	184000	195000	200000
Chromium	Ne	Ne	< 1	1	10	< 20	10
Cobalt	Ne	Ne	< 0.1	< 0.1	< 1	< 2	< 1
Copper	2-4	Ne	< 1	< 1	< 10	< 20	< 10
Iron	300	Ne	**470**	160	500	< 400	500
Lead	1-7	Ne	0.2	0.4	< 1	< 2	< 1
Lithium	Ne	Ne	1.4	0.8	75	102.0	86
Magnesium	Ne	Ne	1720	3070	533000	581000	597000
Manganese	Ne	Ne	22	31	20	< 20	30
Mercury	Ne	Ne	< 0.05	0.51	< 0.05	< 0.05	0.08
Molybdenum	73	Ne	0.7	0.7	4	12.0	4
Nickel	25-150	Ne	< 1	< 1	< 10	< 20	< 10
Potassium	Ne	Ne	690	720	166000	182000	185000
Rubidium	Ne	Ne	0.5	0.6	52	53.0	56
Selenium	1	Ne	< 1	< 1	*	< 50	*
Silver	0.1	Ne	< 0.1	< 0.1	< 1	< 2	< 1
Sodium	Ne	Ne	3660	8440	4200000	4560000	4810000
Strontium	Ne	Ne	78	167	2920	3490	3230
Tellurium	Ne	Ne	< 0.1	< 0.1	1	< 2	< 1
Thallium	0.8	Ne	0.1	< 0.1	< 1	< 2	< 1
Tin	Ne	Ne	< 0.1	< 0.1	< 1	< 2	< 1
Uranium	Ne	Ne	< 0.1	0.1	2	< 2	2
Vanadium	Ne	Ne	< 1	1	< 10	< 20	< 10
Zinc	30	Ne	3	4	10	20	20

*Selenium could not be reported due to matrix based interferences.
shading indicates CCME Guideline exceedances
Ne = no guideline established.

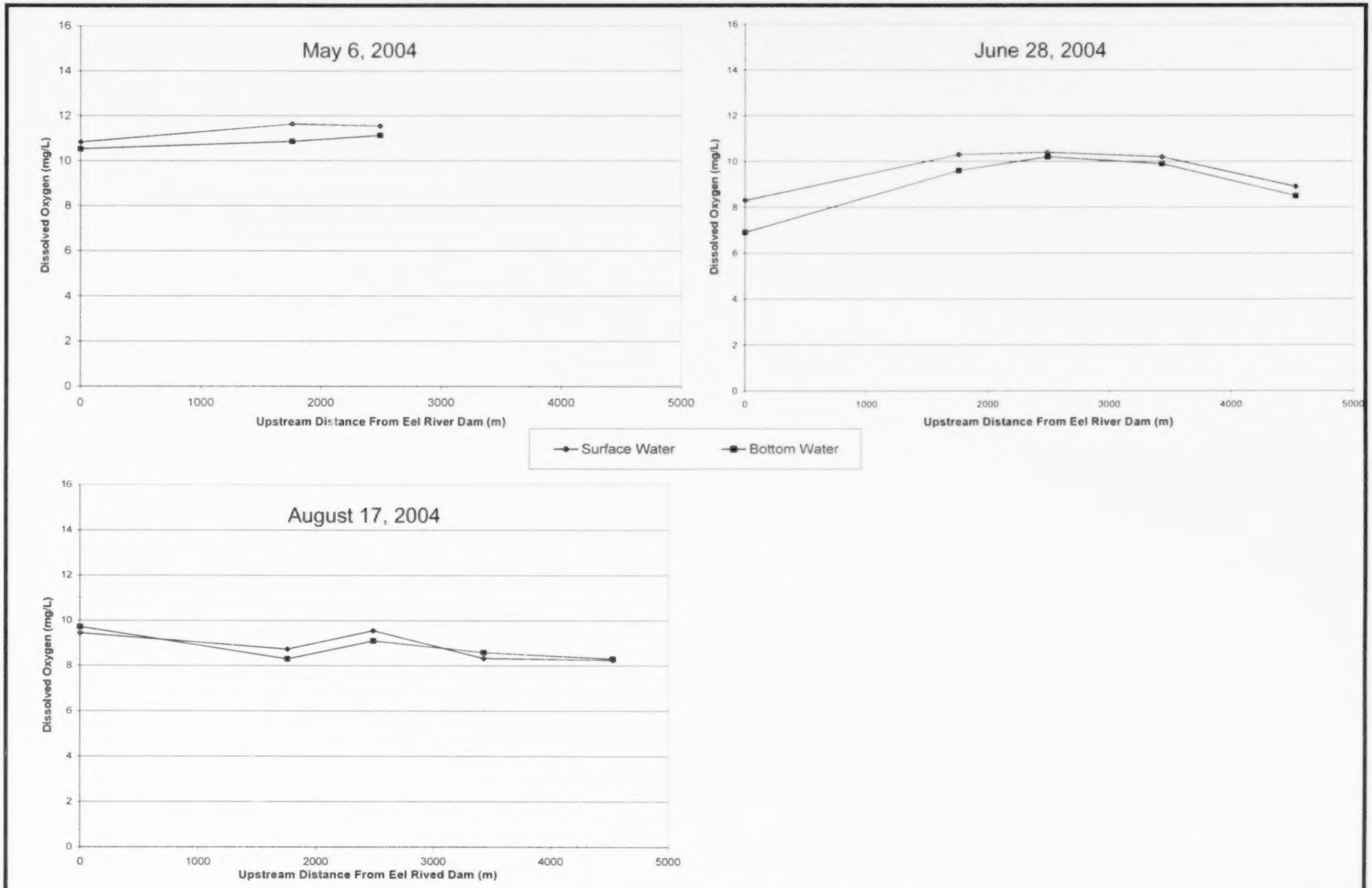
Table 3.4.5 Results of Trace Metals Analysis in the Water at Station TD1 (U1) in 2005.

Trace Metal	July 21			August 18			September 21		
	Sample 1 (freshwater)	Sample 2 (freshwater)	Blank (Distilled water)	Sample 1 (freshwater)	Sample 2 (freshwater)	Blank (Distilled water)	Sample 1 (freshwater)	Sample 2 (freshwater)	Blank (Distilled water)
Aluminum	55	54	< 1	75	77	< 1	74	70	< 1
Antimony	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Arsenic	< 1	1	< 1	5	6	< 1	2	2	< 1
Barium	19	19	< 1	93	92	< 1	50	48	< 1
Beryllium	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	< 1	< 1	< 1	2	2	< 1	< 1	< 1	< 1
Boron	48	50	1	285	300	< 1	80	83	< 1
Cadmium	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Calcium	39400	39200	90	68900	70400	70	40200	40600	< 50
Chromium	< 1	< 1	< 1	< 2	< 2	< 1	1	1	< 1
Cobalt	< 0.1	0.1	< 0.1	< 0.2	0.2	< 0.1	0.2	0.1	< 0.1
Copper	< 1	< 1	8	< 2	< 2	5	1	< 1	< 1
Iron	70	80	< 20	200	210	< 20	140	140	< 20
Lead	0.2	0.2	< 0.1	0.6	0.6	< 0.1	0.7	0.4	< 0.1
Lithium	2.7	2.7	< 0.1	11.2	11.3	< 0.1	3.2	3.0	< 0.1
Magnesium	14100	13700	30	84100	85400	< 10	18400	18400	< 10
Manganese	82	72	< 1	230	228	< 1	77	78	< 1
Mercury	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	1.0	1.0	0.2	1.3	1.3	< 0.1	0.8	1.0	< 0.1
Nickel	< 1	< 1	< 1	< 2	< 2	< 1	< 1	< 1	< 1
Potassium	4730	4640	< 20	27700	28400	< 20	7360	7260	< 20
Rubidium	1.6	1.6	< 0.1	7.4	7.4	< 0.1	2.3	2.2	< 0.1
Selenium	1	2	< 1	< 20	< 20	< 1	< 5[†]	< 5[†]	< 1
Silver	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	96200	99200	< 50	728000	749000	< 50	175000	173000	< 50
Strontium	233	239	2	807	825	< 1	296	296	< 1
Tellurium	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Thallium	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Tin	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Uranium	0.1	0.1	< 0.1	0.3	0.3	< 0.1	0.2	0.2	< 0.1
Vanadium	< 1	1	< 1	< 2	< 2	< 1	1	1	< 1
Zinc	3	2	< 1	< 2	< 2	< 1	3	3	< 1

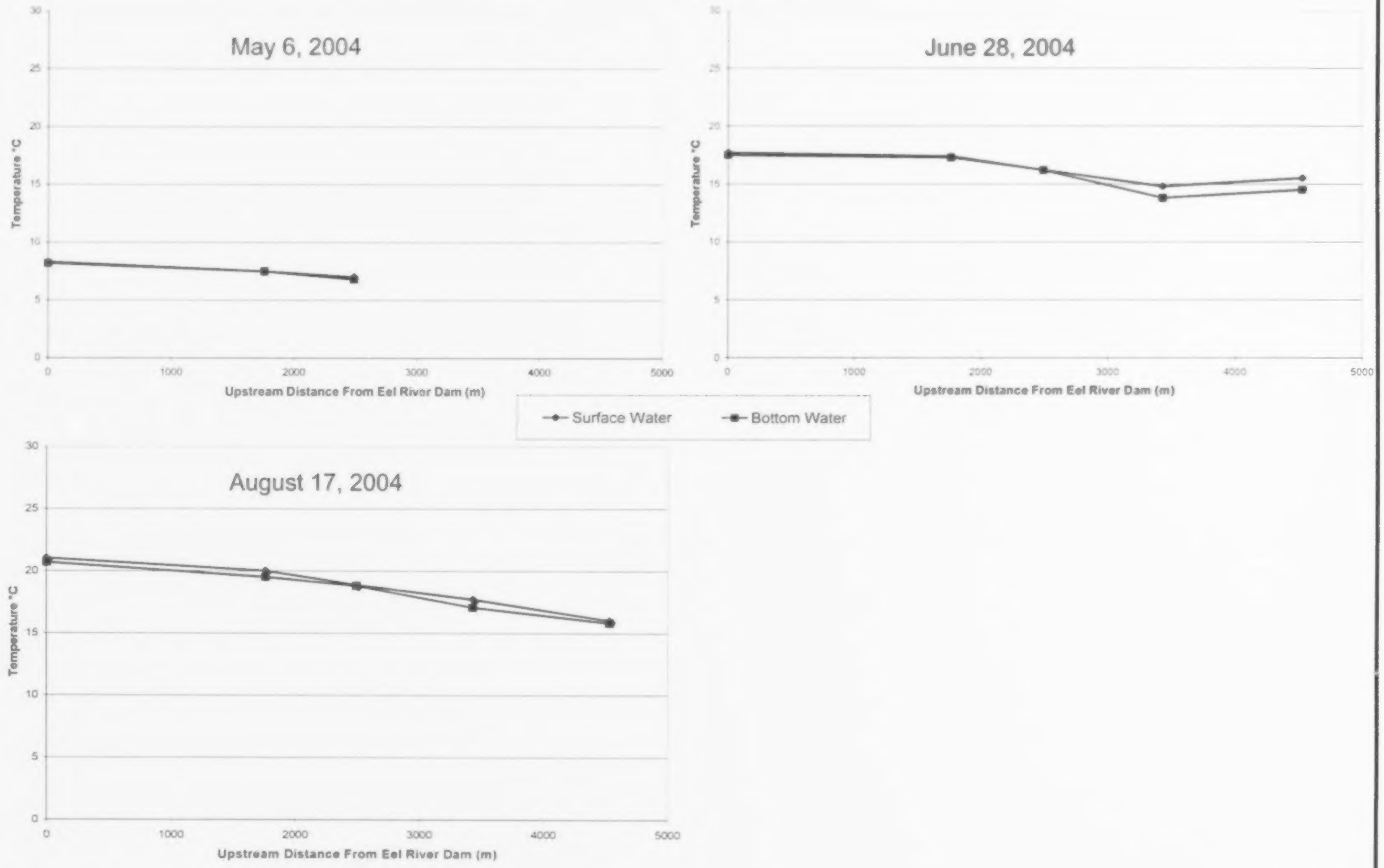


Surface and Bottom Conductivity Levels Measured in 2004 at Different Distances Upstream of the Eel River Dam

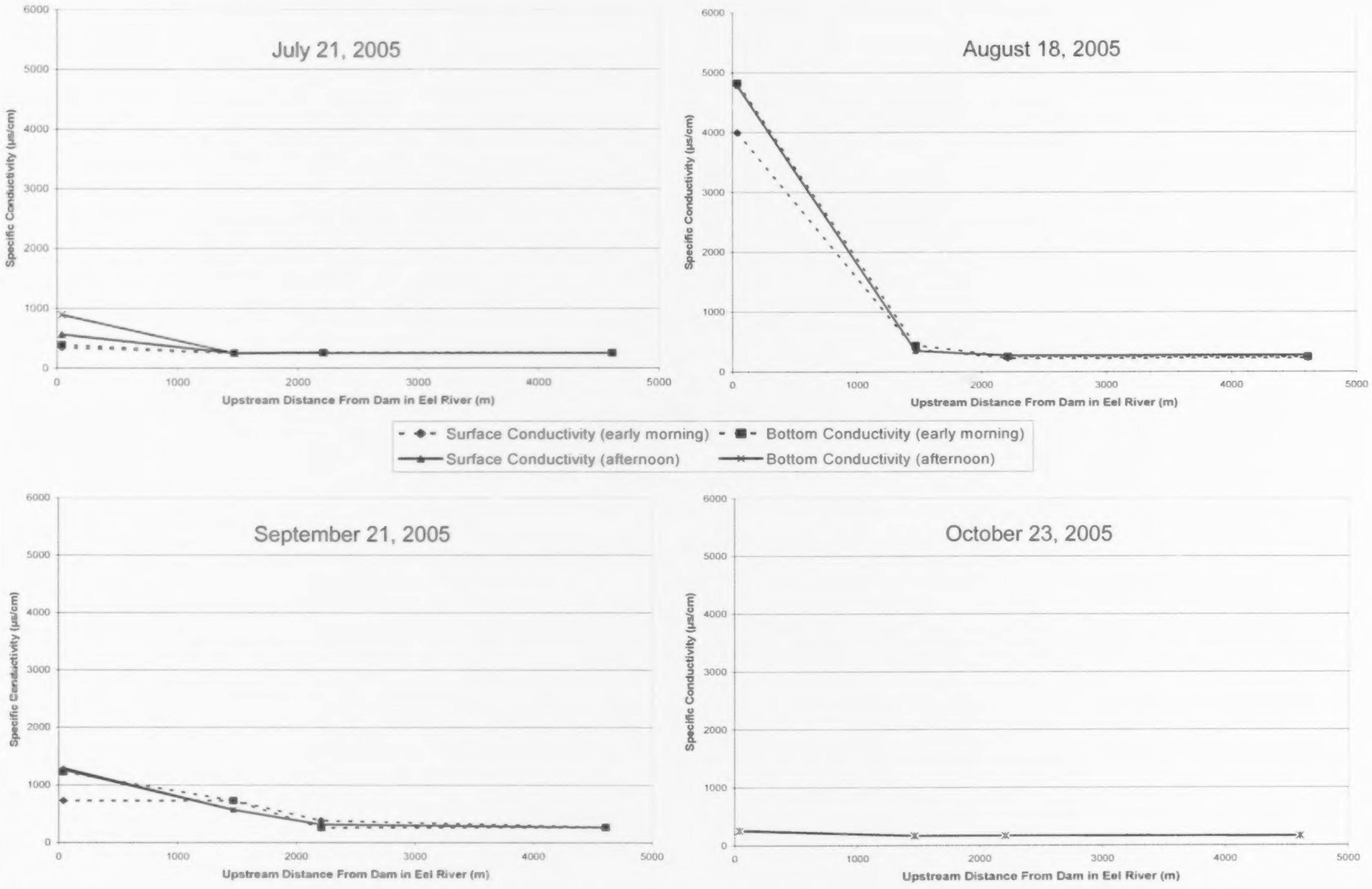
Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
Job No. 15830	Figure No. **3.4.3**	***NBDSS PROJECT No. YR101A***



Surface and Bottom Dissolved Oxygen Levels Measured in 2004 at Different Distances Upstream of the Eel River Dam	Date: 03/31/2006	Scale:	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **3.4.4**	***NBDSS PROJECT No. YR101A***



Surface and Bottom Temperatures Measured in 2004 at Different Distances Upstream of the Eel River Dam	Date: 03/31/2006	Scale:	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. 3.4.5	***NBDSS PROJECT No. YR101A***



Surface and Bottom Conductivity Levels Measured in 2005 at Different Distances Upstream of the Eel River Dam

Date:
03/31/2006

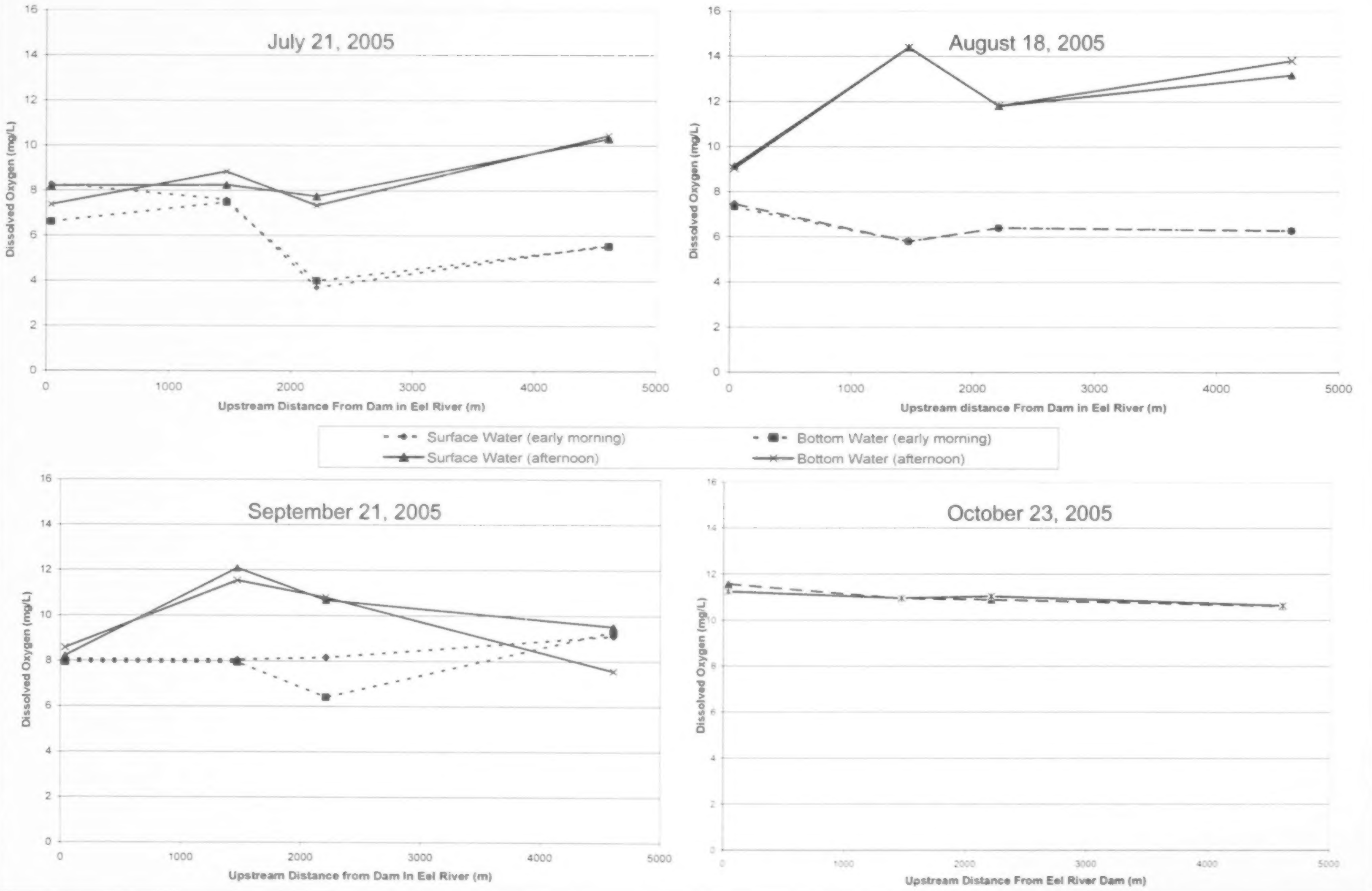
Scale:

Job No.
15830

Figure No.
3.4.6

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT
Brunswick

NBDSS PROJECT No. YR101A



Surface and Bottom Dissolved Oxygen Levels Measured in 2005 at Different Distances Upstream of the Eel River Dam

Date:
03/31/2006

Scale:

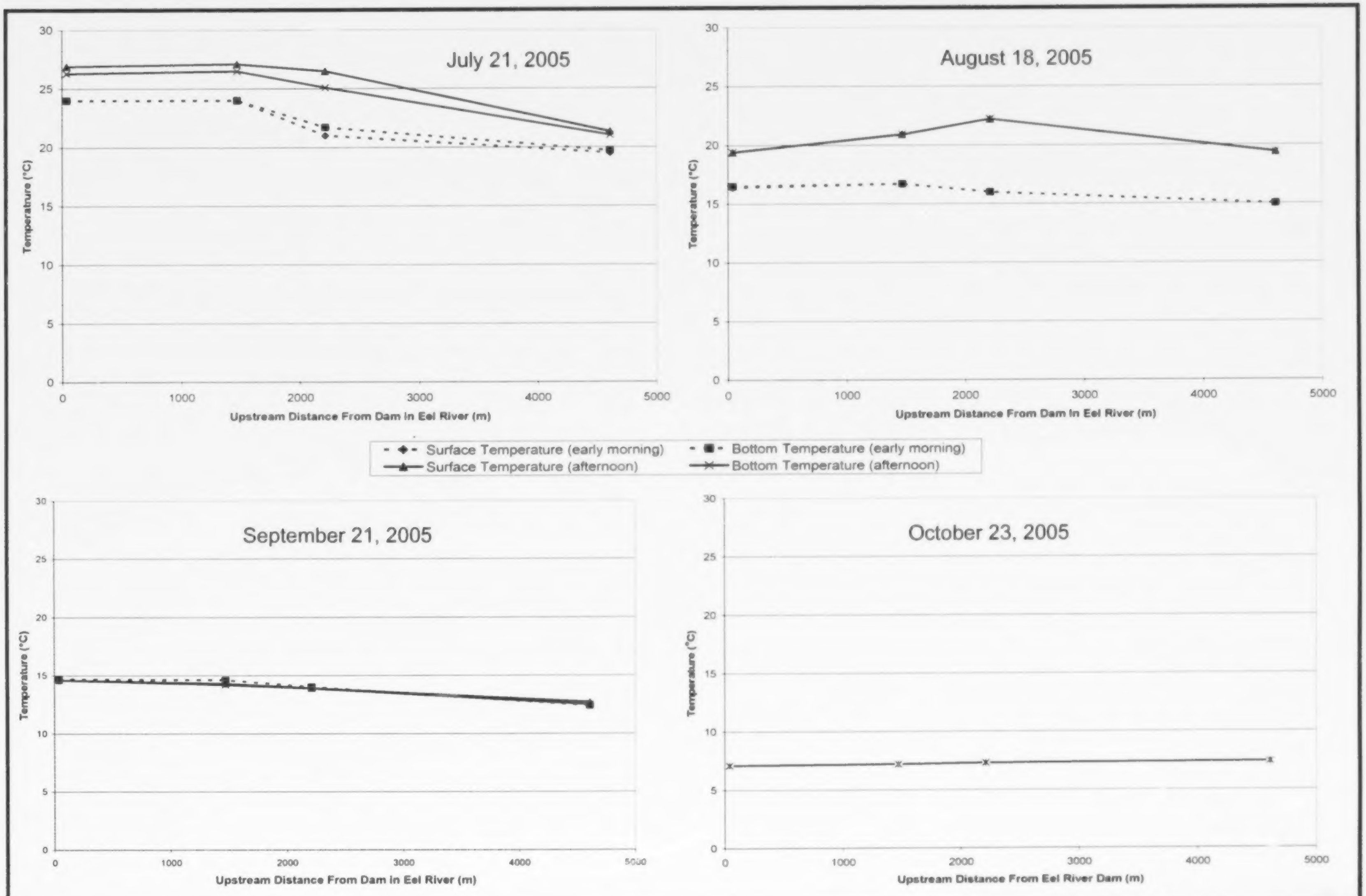
Job No.
15830

Figure No.
3.4.7

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

Brunswick

NBDSS PROJECT No. YR101A



Surface and Bottom Temperatures Measured in 2005 at Different Distances Upstream of the Eel River Dam	Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. 3.4.8	NBDSS PROJECT No. YR101A

In 2005, the DO concentration (as well as temperature and conductivity) was surveyed at selected locations in the impoundment (Stations TD1 to TD4, Figure 3.4.2) on four occasions in July, August, September and October (Table 3.4.7 and Figures 3.4.6 to 3.4.8). During 2005, the stoplogs at the water control structure were reported to be in poor condition, and both low water levels, and saltwater intrusion into the impoundment, were reported. The temperature measurements for 2005 showed a diurnal pattern with significant cooling of the water body (by as much as 5 °C) at night in August, however, surface and bottom water temperatures were similar at all times. The conductivity measurements indicated some degree of saltwater influence in each month, with the greatest marine intrusion being observed in August, when conductivity near the dam approached 5,000 µS/cm. However, surface and bottom salinity measurements were similar at all times. Both the temperature and conductivity results therefore suggest that the impoundment is not significantly stratified. The DO data for 2005 indicate little vertical stratification, with surface and bottom DO concentrations being 0.similar. However, the impoundment typically did experience a DO deficit in the early morning during July, August and September. This was most pronounced in August, when daytime DO concentrations were generally supersaturated (12 to 14 mg/L at water temperatures of 19 to 22 °C) during the daytime, and undersaturated (6 to 8 mg/L at water temperatures of 15 to 17 °C) during the night. This kind of DO variation is characteristic of eutrophic water bodies. A DO concentration of approximately 4 mg/L, which might be limiting to salmonid fish, was observed at a distance of approximately 2.2 km upstream from the dam in the early morning of July 21, 2005.

Secchi depth (used to assess light penetration in water as an indication of trophic state of the water body) was also surveyed together with the DO survey in 2004. Secchi depth in the impoundment was all less than two metres, consistent with the eutrophic state of the impoundment. However, in Eel Bay, Secchi depth up to 3.32 m has been measured, indicating better water quality compared to the impoundment.

Water temperatures (surface and bottom) were monitored at four locations within the impoundment (TD1, TD2, TD3 and TD4, Figure 3.4.2) on a continuous basis from August 18 to October 17, 2005. Bottom water depths at these locations were shallow, ranging from 0.9 to 1.4 m, nominally (exact depths cannot be provided due to water level fluctuations in the impoundment). The water temperature patterns (Figure 3.4.8) were very similar at all stations, and differences between surface and bottom water temperatures were negligible. Peak water temperatures (which occasionally exceeded 25 °C at Stations TD2 and TD3) were observed during late August, and correspond to a period of warm weather as measured at Charlo Airport. Diurnal (day-night) fluctuations in water temperature in some cases exceeded 5 C°, indicating rapid warming and cooling of the water mass in response to warm days with intense solar radiation, followed by cool nights. The water temperatures observed at Station TD2 correspond very closely to temperatures measured by NB Power at the Dalhousie Generating Station cooling water intake (Figure 3.4.9). The NB Power data indicate that water temperatures in the impoundment in 2005 rose rapidly after mid-April from temperatures near freezing during the winter, to peak in mid-July at a temperature of approximately 25 °C, declining steadily after the beginning of September.

The conductivity of water measured in 2005 by NB Power at the Dalhousie Generating Station (Figure 3.4.10) was chronically slightly elevated (200 µS/cm) in the impoundment during 2005, due to problems with the condition of stoplogs at the water control structure. These caused low water levels in the impoundment, and marine water intrusion into the impoundment, until they were repaired in early August. However, immediately following the repair of the stoplogs, higher than normal tides and storm surges combined to cause several consecutive days when the control structure was overtopped and marine water intruded into the impoundment. As a result, the conductivity rose rapidly over several tidal cycles in late August and early September. Accompanying heavy rainfall as measured at Charlo Airport also helped to cause some rapid declines in conductivity, through freshwater flushing.

To summarize, the impoundment presently consists almost entirely of freshwater with low salinity. There are occasions when the tide rises above the top of the gates, and salt water spills into the impoundment. This will result in accumulation of denser and more saline water in the deeper portion of the impoundment, near the dam. However, the volume of this saltwater intrusion is likely limited. The impoundment is eutrophic, having relatively high concentrations of available nutrients, warm water temperatures, and depressed night time oxygen concentrations during the summer months. The combination of an abrupt transition from near-marine salinity to freshwater, together with high water temperatures and periodic low dissolved oxygen concentrations could be stressful or limiting to migratory fish, particularly salmonids. There is presently no evidence of significant contamination of the water in the impoundment by heavy metals or persistent organic pollutants.

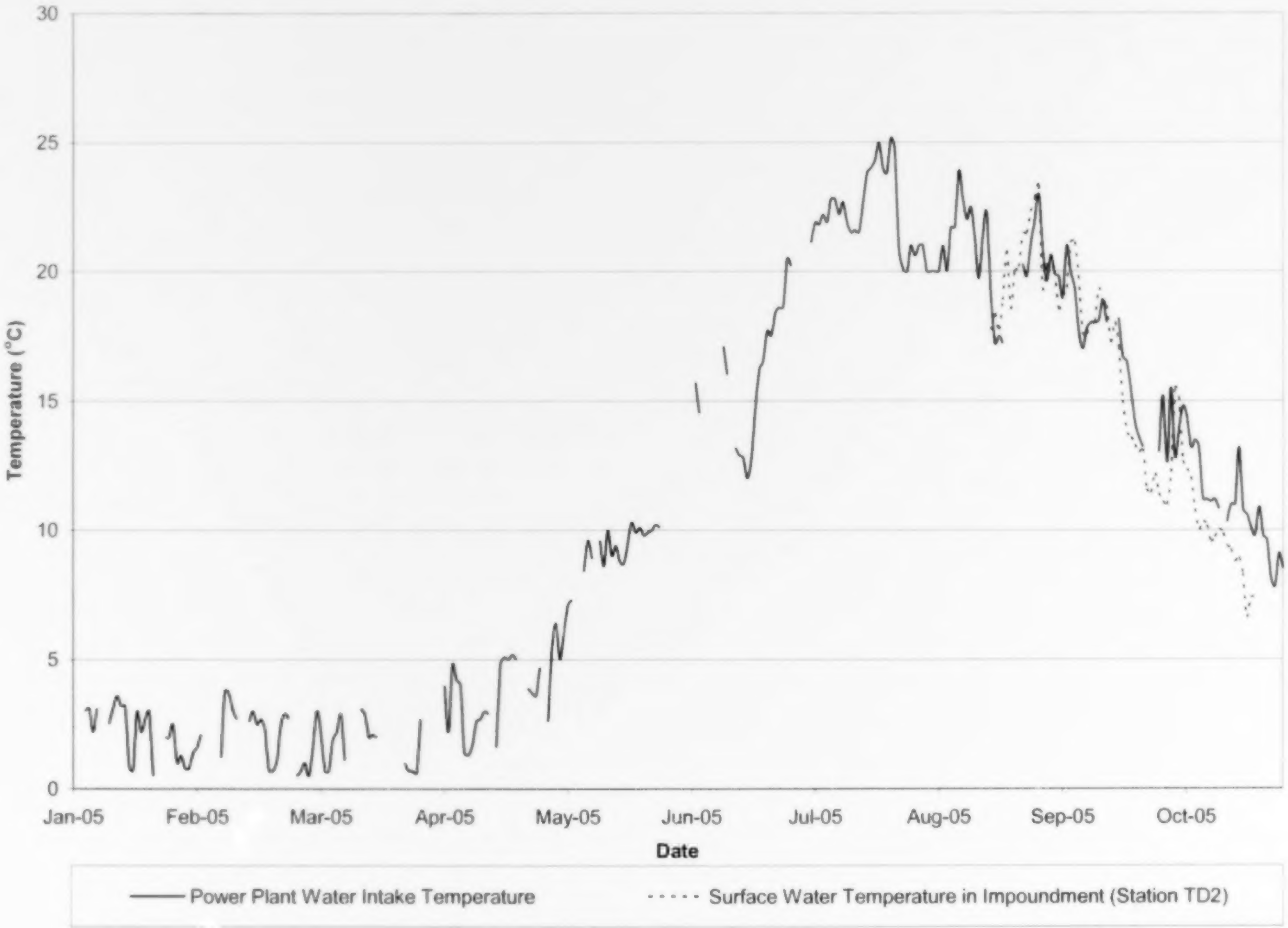
3.4.2 Sediment Quality

3.4.2.1 Pre-dam Conditions

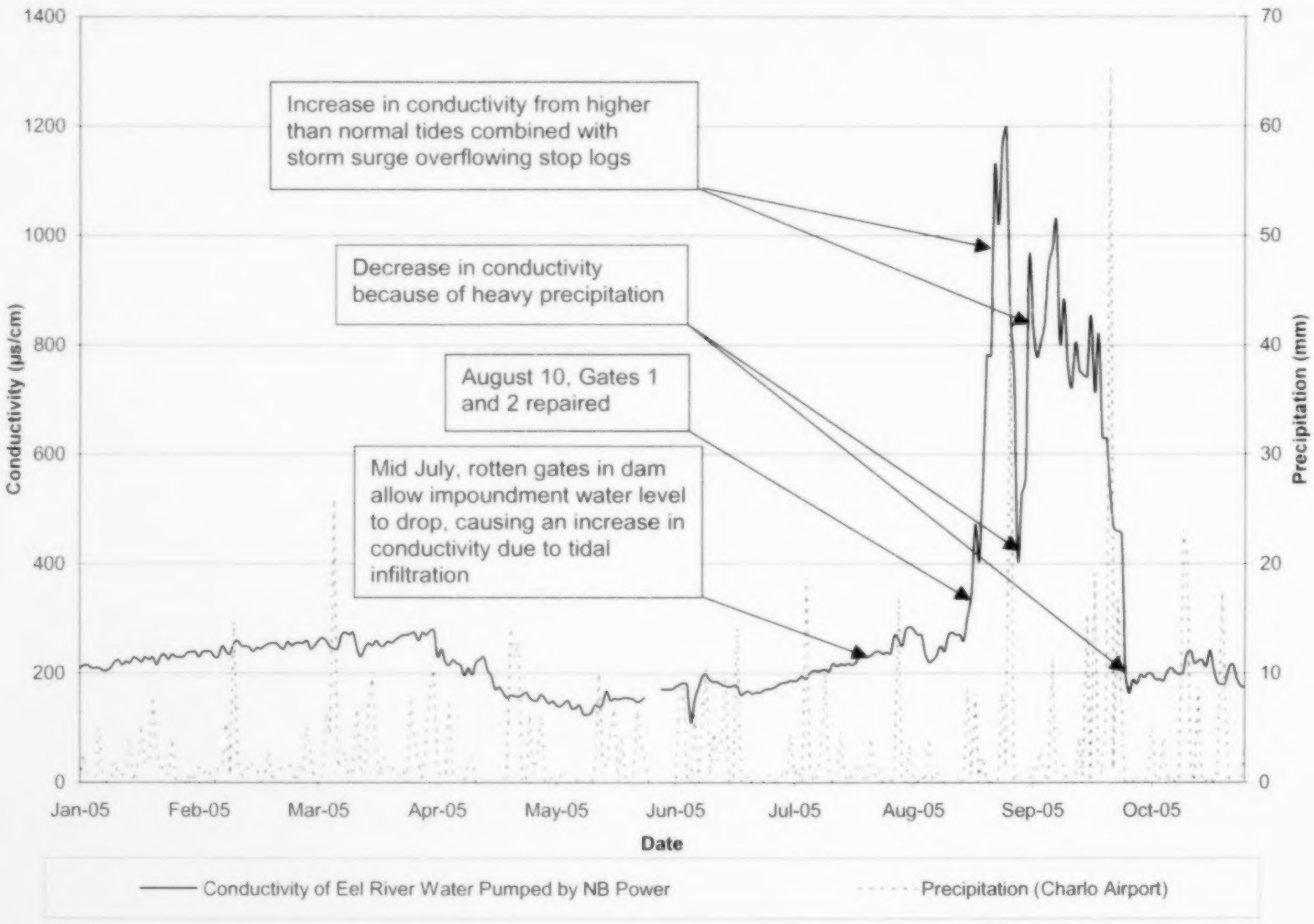
There are no data available on sediment quality in the Eel River system prior to construction of the dam.

3.4.2.2 Post-dam and Existing Conditions

The contamination of sediments is typically from material in suspension in the water that may have settled out. The sources of existing contaminated sediments are likely the same as those identified above for water quality, including sewage, industrial wastes and agricultural runoff.



Water Temperature of the Eel River Impoundment in 2005 as Measured by NB Power at the Dalhousie Generating Station	**Date:** 03/31/2006	**Scale:**	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT New Brunswick
	Job No. 15830	**Figure No.** **3.4.9**	***NBDSS PROJECT No. YR101A***



Increase in conductivity from higher than normal tides combined with storm surge overflowing stop logs

Decrease in conductivity because of heavy precipitation

August 10, Gates 1 and 2 repaired

Mid July, rotten gates in dam allow impoundment water level to drop, causing an increase in conductivity due to tidal infiltration

Conductivity of Water Pumped from the Eel River Impoundment in 2005 and Measured by NB Power at the Dalhousie Generating Station	Date: 03/31/2006	Scale:	Eel River Dam
	Job No. 15830	Figure No. **3.4.10**	***NBDSS PROJECT No. YR101A***

Table 3.4.6 Water Column Profiling Data in the Eel River Area, 2004

Station	Date	Local Time	Tidal Stage	Station Depth (m)	Secchi Depth (m)	Sample Depth (m)	Temp (°C)	Conductivity (µS/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% satur.)	pH
U1	*6-May-04	13:44	Rising	1.75	1.00	0.25	8.3	118.4	0.1	10.83	92.7	
						0.50	8.2	125.4	0.1	10.70	90.9	
						1.00	8.2	126.3	0.1	10.44	89.4	7.8
						1.75	8.2	125.1	0.1	10.53	89.0	
	28-Jun-04	12:15	Rising	1.90	0.90	0.00	17.7	177.1	0.1	8.30	87.3	8.0
						0.25	17.6	177.0	0.1	8.20	86.8	
						0.50	17.6	179.9	0.1	7.80	85.5	
						1.00	17.6	175.0	0.1	8.00	84.8	
						1.80	17.5	179.6	0.1	6.90	80.9	8.0
	17-Aug-04	10:49	Falling	1.70	1.40	0.22	21.0	457.0	0.2	9.45	106.2	8.1
						0.77	20.9	458.0	0.2	9.49	106.4	8.1
						1.65	20.7	456.0	0.2	9.72	108.4	8.1
U2	*6-May-04	13:09	Rising	2.00	1.00	0.25	7.5	118.0	0.1	11.63	97.5	
						0.50	7.5	118.1	0.1	11.20	93.7	
						1.00	7.5	118.1	0.1	11.08	92.2	
						1.75	7.5	130.6	0.1	10.86	91.3	
	28-Jun-04	13:02	Falling	2.30	1.28	0.00	17.4	177.4	0.1	10.30	107.2	7.8
						0.25	17.5	177.4	0.1	10.10	107.2	
						0.50	17.5	177.4	0.1	9.90	103.6	
						1.00	17.5	177.9	0.1	9.80	103.9	
						2.00	17.3	176.8	0.1	9.60	100.3	7.9
	17-Aug-04	10:34	Falling	1.70	1.40	0.22	20.0	462.0	0.2	8.73	96.1	7.6
						1.00	19.7	459.0	0.2	8.58	93.9	7.6
						1.61	19.5	455.0	0.2	8.30	90.0	7.6
U3	*6-May-04	12:30	Rising	1.00	1.00	0.25	7.0	116.8	0.1	11.54	95.5	
						0.50	6.8	116.9	0.1	10.96	89.1	
						0.75	6.8	117.1	0.1	11.13	90.6	
	28-Jun-04	13:38	Falling	1.10	1.08	0.00	16.2	174.1	0.1	10.40	105.4	7.8
						0.25	16.2	174.1	0.1	10.20	104.5	
						0.50	16.2	174.2	0.1	9.70	101.3	
						1.00	16.2	174.0	0.1	10.20	95.6	7.9
	17-Aug-04	10:07	Falling	1.70	1.20	0.21	18.9	443.0	0.2	9.55	102.7	7.8
						0.93	18.8	446.0	0.2	9.10	97.8	7.7

Table 3.4.6 Water Column Profiling Data in the Eel River Area, 2004

Station	Date	Local Time	Tidal Stage	Station Depth (m)	Secchi Depth (m)	Sample Depth (m)	Temp (°C)	Conductivity (µS/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% satur.)	pH
U4	28-Jun-04	14:22	Falling	1.90	1.51	0.00	14.8	172.5	0.1	10.20	102.3	7.6
						0.25	14.2	173.7	0.1	10.20	100.9	
						0.50	14.1	173.3	0.1	10.40	99.1	
						1.00	14.0	173.5	0.1	10.20	99.6	
						1.80	13.8	173.9	0.1	9.90	96.5	7.7
	17-Aug-04	9:52	Falling	1.80	1.70	0.21	17.7	453.0	0.2	8.33	87.5	7.6
						0.90	17.6	452.0	0.2	8.40	88.0	7.6
						1.73	17.1	452.0	0.2	8.59	89.1	7.6
U5	28-Jun-04	15:49	Falling	2.10	2.10	0.00	15.5	173.5	0.1	8.90	89.2	8.0
						0.25	15.1	172.8	0.1	8.90	89.0	
						0.50	14.8	172.6	0.1	8.80	88.0	
						1.00	14.6	170.6	0.1	8.80	87.0	
						2.00	14.5	170.9	0.1	8.50	89.0	8.0
	17-Aug-04	9:25	Falling	1.70	1.70	0.20	16.0	447.0	0.2	8.25	83.7	7.5
						0.90	15.9	441.0	0.2	8.36	84.4	7.5
						1.60	15.8	425.0	0.2	8.30	84.7	7.5
U6	29-Jun-04	13:55	Falling	1.16	1.16	0.00	14.4	35800.0	22.7	9.60	107.2	8.1
						0.25	14.1	36000.0	22.8	9.80	110.5	
						0.50	13.9	36200.0	22.9	9.80	111.0	
						1.00	13.8	36200.0	22.8	9.60	105.5	8.1
	30-Jun-04	8:39	Rising	0.90	0.90	0.00	16.0	22400.0	13.0	7.50	82.5	7.9
						0.25	16.0	21800.0	13.3	7.40	81.0	
						0.50	16.1	22800.0	13.3	7.40	81.1	
						0.80	16.1	22800.0	13.9	7.20	79.1	
	17-Aug-04	15:45	Rising	0.25	0.25	0.25	21.2	24432.0	14.9	10.11	123.0	7.9

Table 3.4.6 Water Column Profiling Data in the Eel River Area, 2004

Station	Date	Local Time	Tidal Stage	Station Depth (m)	Secchi Depth (m)	Sample Depth (m)	Temp (°C)	Conductivity (µS/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% satur.)	pH
U7	*6-May-04	16:30	Rising	7.30	1.50	0.25	6.3	23570.0	14.1	10.98	93.8	
						0.50	5.2	23830.0	14.3	10.79	93.5	
						1.00	5.0	24910.0	14.9	10.81	93.5	
						2.00	5.0	24990.0	15.0	10.83	93.5	
						3.00	5.0	25210.0	15.1	10.84	93.7	7.4
						5.00	3.8	32490.0	20.0	10.78	93.8	
						7.00	2.4	43390.0	26.7	10.83	94.4	
	*7-May-04	9:05	Falling	6.90	NA	0.25	6.2	21310.0	12.7	11.18	98.7	
						0.50	6.1	22260.0	13.3	11.21	86.7	
						1.00	4.0	27010.0	15.9	11.46	88.9	
						2.00	2.8	32270.0	20.7	11.91	102.8	
						3.00	2.3	42160.0	26.2	11.84	99.7	
						4.00	2.0	34480.0	27.1	11.90	103.0	7.4
						5.00	2.0	43570.0	27.1	12.07	104.9	
						6.00	1.9	44040.0	27.5	11.93	103.5	
U7	29-Jun04	14:25	Falling	6.90	3.32	0.00	15.0	35100.0	22.2	9.30	105.5	8.0
						0.25	14.5	35300.0	22.3	9.30	105.0	
						0.50	14.0	35400.0	22.3	9.30	104.9	
						1.00	13.3	35600.0	22.5	9.50	106.5	
						2.00	12.1	36400.0	23.0	10.00	106.0	
						3.00	11.8	37200.0	23.5	9.80	105.0	
						4.00	11.9	37400.0	23.7	9.80	105.4	
						5.00	11.9	37500.0	23.8	10.00	106.6	
						6.00	10.8	40600.0	25.9	10.50	111.6	8.1
	29-Jun-04	9:00	Rising	5.90	2.72	0.00	12.3	35100.0	22.1	9.30	99.8	7.9
						0.25	12.3	35200.0	22.1	9.10	98.7	
						0.50	12.3	35100.0	22.2	9.00	98.5	
						1.00	12.0	36300.0	23.0	8.90	97.0	
						2.00	11.5	38000.0	24.1	9.60	102.3	
						3.00	11.0	39400.0	25.0	8.90	94.5	
						4.00	10.4	40200.0	25.6	8.70	93.6	
						5.00	9.9	41100.0	26.2	7.90	81.2	
						5.80	9.5	41900.0	26.8	7.80	76.4	7.9
	17-Aug-04	15:16	Rising	6.40	1.40	0.36	19.0	25776.0	15.8	9.32	110.7	7.8
						3.10	17.0	30357.0	18.8	8.52	98.8	7.8
						6.34	16.6	41543.0	26.8	7.89	95.2	7.8

‰ practical salinity unit expressed as parts per thousand
µS/cm = micro-siemens per centimetre
* Gate 4 was open during sampling on May 6 and May 7, 2004. The gates were closed on all other dates.
N/A = Not available

Table 3.4.7 Water Column Profiling Data in the Eel River Area, 2005

Station Name	*Date	Local Time	Tide	Station Depth (m)	Sample Depth (m)	Temperature (°C)	Conductivity (µS/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% satur.)	pH
TD1 (U1)	21/07/05	6:05	Ebbing	1.2	0.0	24.0	344	0.2	8.30	85.5	8.9
TD1 (U1)	21/07/05	6:05	Ebbing	1.2	1.0	24.0	389	0.2	6.61	78.3	9.0
TD1 (U1)	21/07/05	15:47	Flooding	1.2	0.0	26.9	564	0.3	8.21	102.5	8.5
TD1 (U1)	21/07/05	15:47	Flooding	1.2	1.1	26.3	895	0.4	7.38	103.5	8.5
TD1 (U1)	18/08/05	8:15	Ebbing	0.8	0.2	16.4	4261	2.6	7.45	75.8	8.1
TD1 (U1)	18/08/05	8:15	Ebbing	0.8	0.7	16.5	4824	2.5	7.32	73.4	8.2
TD1 (U1)	18/08/05	13:30	Flooding	0.8	0.2	19.4	4782	2.5	9.15	100.6	8.4
TD1 (U1)	18/08/05	13:30	Flooding	0.8	0.7	19.4	4785	2.5	9.03	98.9	8.4
TD1 (U1)	21/09/05	7:45	Ebbing	1.6	0.0	14.6	728	0.06	8.05	79.1	8.2
TD1 (U1)	21/09/05	7:45	Ebbing	1.6	1.4	14.6	1226	0.06	7.94	78.1	8.2
TD1 (U1)	21/09/05	16:10	Flooding	1.6	0.0	14.6	1294	0.6	8.22	81.0	8.3
TD1 (U1)	21/09/05	16:10	Flooding	1.6	1.4	14.6	1263	0.6	8.58	84.7	8.3
TD1 (U1)	23/10/05	12:15	Flooding	1.6	0.0	7.1	263	0.1	10.62	88.1	8.1
TD1 (U1)	23/10/05	12:15	Flooding	1.6	1.4	7.1	252	0.1	10.69	59.4	8.0
TD2	21/07/05	6:25	Ebbing	0.8	0.0	24.0	247	0.1	7.60	89.6	8.7
TD2	21/07/05	6:25	Ebbing	0.8	0.8	24.0	247	0.1	7.48	88.5	8.8
TD2	21/07/05	14:35	Flooding	0.8	0.0	27.1	250	0.1	8.25	104.3	8.2
TD2	21/07/05	14:35	Flooding	0.8	0.8	26.5	247	0.1	8.84	111.2	8.4
TD2	18/08/05	7:24	Ebbing	0.5	0.2	16.7	444	0.2	5.80	59.4	7.9
TD2	18/08/06	14:10	Flooding	0.5	0.2	20.9	349	0.1	14.39	161.4	9.1
TD2	21/09/05	7:35	Ebbing	1.1	0.0	14.6	728	0.4	8.05	79.1	8.2
TD2	21/09/05	7:35	Ebbing	1.1	1.0	14.6	727	0.4	7.94	78.1	8.2
TD2	21/09/05	15:55	Flooding	1.1	0.0	14.3	567	0.3	12.09	118.9	8.8
TD2	21/09/05	15:55	Flooding	1.1	1.0	14.2	567	0.3	11.55	111.8	8.8
TD2	23/10/05	12:00	Flooding	1.1	.0.	7.2	167	0.1	11.56	96.5	8.1
TD2	23/10/05	12:00	Flooding	1.1	0.3	7.2	166	0.1	11.24	92.5	8.1
TD3	21/07/05	6:40	Ebbing	0.5	0.0	21.0	257	0.1	3.69	42.1	7.9
TD3	21/07/05	6:40	Ebbing	0.5	0.5	21.7	255	0.1	3.99	44.9	7.9
TD3	21/07/05	14:20	Flooding	0.9	0.0	26.5	261	0.1	7.75	94.2	8.2
TD3	21/07/05	14:20	Flooding	0.9	0.9	25.1	251	0.1	7.34	91.8	8.1
TD3	19/08/05	7:00	Ebbing	0.5	0.2	16.0	258	0.1	6.40	67.6	8.0
TD3	18/08/05	15:05	Flooding	0.5	0.2	22.2	272	0.1	11.81	133.4	8.6
TD3	21/09/05	7:25	Ebbing	1.1	0.0	14.0	378	0.2	8.15	78.8	8.0
TD3	21/09/05	7:25	Ebbing	1.1	1.0	14.0	376	0.2	8.04	77.3	8.1
TD3	21/09/05	15:20	Flooding	1.1	0.0	13.9	317	0.2	10.68	104.1	8.4
TD3	21/09/05	15:20	Flooding	1.1	1.0	13.9	311	0.1	10.80	106.3	8.4
TD3	23/10/05	11:45	Flooding	1.1	0.0	7.3	167	0.1	10.94	90.5	8.1

Table 3.4.7 Water Column Profiling Data in the Eel River Area, 2005

Station Name	*Date	Local Time	Tide	Station Depth (m)	Sample Depth (m)	Temperature (°C)	Conductivity (µS/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% satur.)	pH
TD3	23/10/05	11:45	Flooding	1.1	1.0	7.3	167	0.1	10.96	91.0	8.1
TD4 (U5)	21/07/05	7:05	Ebbing	1.0	0.0	19.5	253	0.1	5.59	61.3	7.8
TD4 (U5)	21/07/05	7:05	Ebbing	1.0	1.0	19.7	252	0.1	5.53	60.8	7.8
TD4 (U5)	21/07/05	13:55	Flooding	1.0	0.0	21.3	251	0.1	10.31	116.5	8.2
TD4 (U5)	21/07/05	13:55	Flooding	1.0	0.9	21.0	252	0.1	10.44	112.6	8.3
TD4 (U5)	19/08/05	6:35	Ebbing	0.5	0.2	15.0	247	0.1	6.28	13.2	8.0
TD4 (U5)	18/08/05	15:40	Flooding	0.5	0.2	19.4	277	0.1	13.18	141.9	8.3
TD4 (U5)	21/09/05	7:15	Ebbing	1.4	0.0	12.4	265	0.1	9.11	85.0	8.1
TD4 (U5)	21/09/05	7:15	Ebbing	1.4	0.0	12.4	267	0.1	9.30	86.9	8.2
TD4 (U5)	21/09/05	15:20	Flooding	1.4	1.3	12.7	265	0.1	9.52	92.4	8.1
TD4 (U5)	21/09/05	15:20	Flooding	1.4	1.3	12.5	265	0.1	7.56	85.9	8.1
TD4 (U5)	23/10/05	11:30	Flooding	1.4	1.3	7.4	163	0.1	10.89	162.8	8.2
TD4 (U5)	23/10/05	11:30	Flooding	1.4	1.3	7.4	164	0.1	11.03	164.0	8.2

‰ practical salinity unit expressed as parts per thousand
µS/cm = micro-siemens per centimetre
* Gates were closed on all sampling dates 2005

In June 2004, nine core samples were taken using manual sediment core samplers (Figure 3.4.11 and Appendix D). From each core, a 1 cm section was taken at every 5 cm depth interval and composited into a sample for analysis. The core lengths ranged from 0.20 to 0.55 m. The remaining sediment from each sample was archived. All nine samples were analyzed for grain size, ammonia and total organic carbon (TOC) (Table 3.4.8). Sediments within the impoundment are primarily silty or sandy, and contain relatively high concentrations of ammonia (reflecting the eutrophic condition). Sediments in the estuary below the dam and nearby marine areas are predominantly sandy or sand-gravel, and contain much lower concentrations of ammonia. The coarser sediment grain size reflects the higher energy regime of the tidally influenced estuary below the dam, while the lower ammonia concentrations in those sediments reflect the higher flushing rates.

Table 3.4.8 Grain Size, Ammonia, and TOC Analysis of Sediment from the Eel River Area, June 28-29, 2004

Component	Station								
	C1 Freshwater	C2 Freshwater	C3 Freshwater	C4 Freshwater	C5 Freshwater	C6 Estuary	C7 Marine	C8 Marine	C9 Marine
% Gravel	4.1	0	1	3.5	12	47.9	0	1	15.3
% Sand	56.6	18.4	21.3	44.6	30.8	48.1	57.6	79.6	60.8
% Silt	24.4	66.9	68.8	43.7	45.1	2.5	39	15.7	18
% Clay	14.9	14.7	8.9	8.2	12.1	1.4	3.4	3.8	6
Ammonia (mg/kg as N)	36	31	24	18	12	1.4	2	1	< 0.5
Total Organic Carbon (%)	4.4	2.4	1.6	1.4	2	0.2	0.3	0.7	0.8

Based on the results of the analysis for grain size, TOC and ammonia, only the samples with high TOC and/or high silt/clay content (*i.e.*, organic or fine-grained sediments in which potential contaminants would most likely be concentrated) were submitted for further analysis. As a result, three samples (C2, C4 and C8) were also analyzed for trace metals, PAHs, and total PCBs. The sediment sample from the estuary below the dam was not included in the additional analyses because it did not exhibit the above noted factors. For parameters with a guideline identified in the CCME Canadian Sediment Guidelines for the Protection of Aquatic Life (CCME, 2003b), only chromium levels in the freshwater sediments exceeded the Interim Guidelines (37.3 mg/kg dry weight). No parameters exceeded the Probable Effect Level Guidelines. The results of the analyses and the relevant guidelines are presented in Tables 3.4.9 and (Table 3.4.10) respectively. Shaded values indicate Guideline exceedences. It is particularly noteworthy that mercury concentrations were well below the CCME guidelines, since a previous issues scoping for the Eel River dam (BMA and CG&S, 2000) raised concern about the possible presence of mercury in water of the impoundment.

Table 3.4.9 Trace Metals Analysis in Sediment from the Eel River Area, June 28-29, 2004

		CCME Guidelines				Station				
		Freshwater		Marine						
	Detection Limit	ISQG[1]	PEL[2]	ISQG[1]	PEL[2]	C2 (freshwater)	C2 Lab Duplicate	C4 (freshwater)	C4 Lab Duplicate	C8 (marine)
Parameters Analyzed	**Concentration (mg/kg)**									
Aluminum	1	Ne	Ne	Ne	Ne	16500	16500	14400	14200	14700
Antimony	0.1	Ne	Ne	Ne	Ne	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Arsenic	1	5.9	17.0	7.24	41.6	3	3	4	4	6
Barium	1	Ne	Ne	Ne	Ne	22	22	25	22	25
Beryllium	0.1	Ne	Ne	Ne	Ne	0.6	0.6	0.7	0.6	0.7
Bismuth	1	Ne	Ne	Ne	Ne	6	3	< 1	< 1	< 1
Boron	1	Ne	Ne	Ne	Ne	12	14	19	14	12
Cadmium	0.1	0.6	3.5	0.7	4.2	0.2	0.2	0.3	0.2	0.5
Calcium	50	Ne	Ne	Ne	Ne	3880	3840	3480	3330	23100
Chromium	1	37.3	90.0	52.3	160	**40**	**40**	**44**	**43**	49
Cobalt	0.1	Ne	Ne	Ne	Ne	11.2	11.0	11	11	12
Copper	1	35.7	197.0	18.7	108	10	11	10	10	11
Iron	2	Ne	Ne	Ne	Ne	26800	27200	23700	22800	22200
Lead	0.1	35.0	91.3	30.2	112	7.2	7.0	7.8	7.3	13.8
Lithium	0.1	Ne	Ne	Ne	Ne	27.6	28.9	24.3	23.8	21.2
Magnesium	10	Ne	Ne	Ne	Ne	10900	10900	9850	9680	11800
Manganese	1	Ne	Ne	Ne	Ne	205	204	212	206	362
Mercury	0.01	0.17	0.486	0.13	0.70	0.04	0.06	0.03	0.03	0.03
Molybdenum	0.1	Ne	Ne	Ne	Ne	1.1	0.8	2	2	1
Nickel	1	Ne	Ne	Ne	Ne	50	50	48	48	48
Potassium	20	Ne	Ne	Ne	Ne	2020	2040	1530	1530	1670
Rubidium	0.1	Ne	Ne	Ne	Ne	15.7	15.6	12	12	8
Selenium	1	Ne	Ne	Ne	Ne	< 1	< 1	< 1	< 1	< 1
Silver	0.1	Ne	Ne	Ne	Ne	0.2	0.1	< 0.1	< 0.1	< 0.1
Sodium	50	Ne	Ne	Ne	Ne	990	1060	1150	1110	4560
Strontium	1	Ne	Ne	Ne	Ne	33	33	28	27	36
Tellurium	0.1	Ne	Ne	Ne	Ne	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thallium	0.1	Ne	Ne	Ne	Ne	< 0.1	< 0.1	0.1	0.1	0.3
Tin	0.1	Ne	Ne	Ne	Ne	< 0.1	< 0.1	< 0.1	0.4	0.5
Uranium	0.1	Ne	Ne	Ne	Ne	0.8	0.7	2	1	0
Vanadium	1	Ne	Ne	Ne	Ne	31	30	32	29	30
Zinc	2	123.0	315.0	124	271	60	62	59	57	86

[1] ISQG: Interim sediment quality guideline (CCME, 2003b). Shading indicates ISQG exceedance.

[2] PEL: Probable effects level guideline (CCME, 2003b).

Samples were air dried and sieved at 1mm. A portion was digested according to EPA Method 3050. The resulting solution was diluted to volume for trace element analysis by ICP-MS and ICP-ES. Mercury was analyzed by Cold Vapour AAS.

Ne = no guideline established. Shading indicates exceedances of CCME Guidelines

mg/kg = parts per million (ppm).

Table 3.4.9 shows metal concentrations in sediment samples collected from the Eel River area in June 2004. Concentrations of chromium in sediment were highlighted (shaded) to show that they exceeded the CCME Interim Sediment Quality guideline (ISQG, 37.3 mg/kg). The sediment samples in question, both from the freshwater portion of the Eel River system, were C2 and C4 (both original and lab duplicate analyses). The chromium concentrations (maximum of original and duplicate analyses) for these samples were 40 and 44 mg/kg.

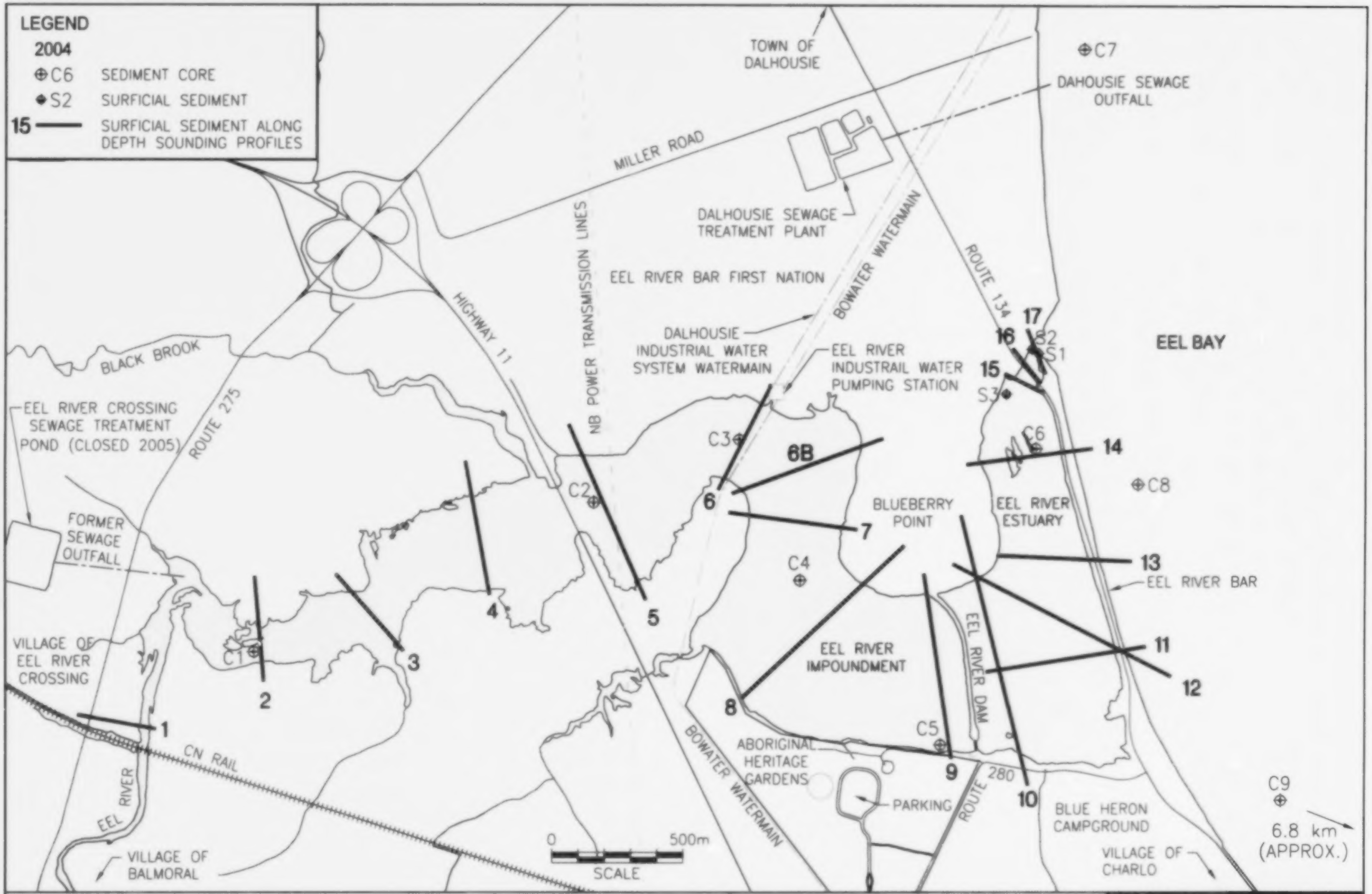
Data from stream-sediment surveys in the Balmoral area show high levels of chromium (NBDNR, 1998). Stream-sediment data from the south side of the middle branch of Eel River, near Balmoral, indicate chromium concentrations of 150 mg/kg. Some samples exceed 200 mg/kg along the north branch of the Charlo River, south of Saint Maure. Other stream-sediment data in the Tetagouche Lakes area show a range of chromium levels from 23 mg/kg to 350 mg/kg (NBDNR, 2003b). Based upon these data, it would appear that chromium concentrations in stream sediments are naturally elevated in the Charlo and Eel River area. The slightly elevated concentrations of chromium measured in the Eel River impoundment area could, therefore, be attributable to natural sources.

Significant environmental effects are not likely to occur in either the freshwater or the marine environment at chromium concentrations as low as 44 mg/kg. Other sources of benchmarks for environmental effects include the Oak Ridge document "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota" (Jones *et al.*, 1997), which states that the USEPA Threshold Effects Level value of 52.3 mg/kg appears to be a reliable indicator of the threshold for effects. On this basis, although the measured chromium concentration slightly exceeds the CCME ISQG value, the measured concentrations of chromium may well be of natural origin, and are not sufficiently high to be of concern for potential effects on freshwater or marine fauna.

Table 3.4.10 shows PAH and total PCB concentrations in sediment from the Eel River area. Although traces of some PAH compounds were detected, the concentrations were all below CCME guidelines, and are not sufficiently elevated to be of concern. Many PAH compounds occur naturally, often being formed as products of combustion (forest fires, wood and coal burning, etc.) in addition to being found in hydrocarbons and tars. PAHs are considered to be hydrophobic compounds, partitioning into the organic carbon fraction of sediments. Therefore, the presence of low concentrations of PAH in the sediments of the impoundment is not surprising, given the location of the impoundment at the lower end of the watershed, with several villages, roads, and other infrastructure located within the catchment.

Table 3.4.10 also shows total PCB concentrations measured (not detectable) in the sediments. The absence of detectable PCB residues in the sediments indicates that there has been no significant release of PCBs to the Eel River watershed. The use of PCBs in Canada was phased out during the 1980's, but these compounds were formerly widely used in electrical transformers, as well as having a variety of other uses.

FILE: 15830\EIA REPORT\SEDIMENT SAMPLING


LEGEND
2004
⊕C6 SEDIMENT CORE
◆S2 SURFICIAL SEDIMENT
15 SURFICIAL SEDIMENT ALONG DEPTH SOUNDING PROFILES
TOWN OF DALHOUSIE
C7
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
BOWATER WATERMAIN
ROUTE 134
HIGHWAY 11
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
17
16
S2
S1
15
S3
EEL BAY
BLACK BROOK
ROUTE 275
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
C3
6B
C6
14
C2
6
7
BLUEBERRY POINT
EEL RIVER ESTUARY
C8
FORMER SEWAGE OUTFALL
C4
13
EEL RIVER BAR
4
5
VILLAGE OF EEL RIVER CROSSING
C1
2
3
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
11
12
1
8
CN RAIL
C5
ABORIGINAL HERITAGE GARDENS
9
280
ROUTE
10
BLUE HERON CAMPGROUND
C9
EEL RIVER
PARKING
BOWATER WATERMAIN
6.8 km (APPROX.)
0
500m
SCALE
VILLAGE OF BALMORAL
VILLAGE OF CHARLO

LOCATION OF SEDIMENT SAMPLING STATIONS IN 2004

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 3.4.11

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

To summarize the sediment quality data, sediments within the impoundment contain more silt and ammonia than sediments in the estuary below the dam, consistent with the quiescent nature of the water body, and its eutrophic condition. However, concentrations of heavy metals and persistent organic pollutants are low, indicating that there has been no significant introduction of chemical pollutants, other than nutrients, to the system.

Table 3.4.10 PAHs and Total PCBs in Sediment from the Eel River Area, June 28-29, 2004

		CCME Guidelines				Station		
		Freshwater		Marine				
	Detection Limit	ISQG[1]	PEL[2]	ISQG[1]	PEL[2]	C2 (freshwater)	C4 (freshwater)	C8 (marine)
Parameters Analyzed	Concentration (mg/kg)							
Naphthalene	0.01	0.0346	0.391	0.0346	0.391	0.01	<0.1	<0.1
Acenaphthylene	0.01	0.00587	0.128	0.00587	0.128	<0.1	<0.1	<0.1
Acenaphthene	0.01	0.00671	0.0889	0.00671	0.0889	<0.1	<0.1	<0.1
Fluorene	0.01	0.0212	0.144	0.0212	0.144	<0.1	<0.1	<0.1
Phenanthrene	0.01	0.0419	0.515	0.0867	0.544	0.01	<0.1	<0.1
Anthracene	0.01	0.0469	0.245	0.0469	0.245	<0.1	<0.1	<0.1
Fluoranthene	0.01	0.111	2.355	0.113	1.494	0.02	0.02	<0.1
Pyrene	0.01	0.053	0.875	0.153	1.398	0.02	0.02	<0.1
Bz(a)anthracene	0.01	0.0317	0.385	0.0748	0.693	0.01	<0.1	<0.1
Chrysene/Triphenylene	0.01	0.0571	0.862	0.108	0.846	0.01	<0.1	<0.1
Bz(b)fluoranthene	0.01	Ne	Ne	Ne	Ne	0.01	<0.1	<0.1
Bz(k)fluoranthene	0.01	Ne	Ne	Ne	Ne	0.01	<0.1	<0.1
Bz(e)pyrene	0.01	Ne	Ne	Ne	Ne	0.01	<0.1	<0.1
Bz(a)pyrene	0.01	0.0319	0.782	0.0888	0.763	0.01	<0.1	<0.1
Indenopyrene	0.01	Ne	Ne	Ne	Ne	0.01	<0.1	<0.1
Bz(g,h,i)perylene	0.01	Ne	Ne	Ne	Ne	0.01	<0.1	<0.1
Dibz(a,h)anthracene	0.01	0.00622	0.135	0.00622	0.135	<0.1	<0.1	<0.1
Moisture Content (%)	0.01	Ne	Ne	Ne	Ne	47	5.5	28
Total PCBs	0.05	0.0341	0.277	0.0215	0.189	<0.05	<0.05	<0.05

[1] ISQG: Interim sediment quality guideline (CCME, 2003b). Shading indicates ISQG exceedance.
[2] PEL: Probable effects level guideline (CCME, 2003b).
Ne = no guideline established.
mg/kg = parts per million (ppm).

3.4.3 Fish

3.4.3.1 Pre-dam Conditions

3.4.3.1.1 Diadromous Fish

Prior to the construction of the dam, diadromous fish had uninhibited access to and from Eel River. These species included:

- American eel;
- rainbow smelt;
- American shad;
- gaspereau (blueback herring + alewife);

- sea lamprey;
- Atlantic salmon;
- brook trout; and
- Atlantic tomcod.

Of these species, most are anadromous in that they spawn in freshwater, their offspring have a nursery period of varying duration in freshwater, and then move to the marine environment where they forage and mature. One exception is the American eel, which is catadromous, meaning that it spawns in saltwater and feeds and matures primarily in freshwater. The sea-run brook trout is also not truly anadromous in that it does not fully enter the marine environment, instead foraging for a time in the estuary or any large lentic (slow-moving) waterbody (brackish) that is situated at the end of its home river. This life style is termed amphidromy.

Of these diadromous species, the Atlantic salmon was probably the most important prior to dam construction. Since the construction of the dam, salmon have entered Eel River primarily in the fall, prior to spawning. Before the dam was constructed at least a portion of the salmon migration is thought to have occurred earlier in the season. In high water years, a few grilse (small mature salmon that have spent only one winter in the ocean) were known to enter the river as early as the first week of August and were caught at the Village of Eel River Crossing (Quigley, pers. comm.). The migration timing of other diadromous fish species are not thought to have changed since the dam was constructed. Migration timings are also further discussed in Section 3.4.3.2.

3.4.3.1.2 Freshwater Fish Community

There is no data available about the resident fish community of Eel River prior to construction of the dam. However, the community would likely have been composed of species typical of streams draining into the Gulf of St. Lawrence, including brook trout, white suckers (*Catostomus commersoni*), red belly dace (*Chrosomus eos*), slimy sculpin (*Cottus cognatus*), stickleback (*Gasterostidae spp.*), yellow perch (*Perca flavescens*), blacknose dace (*Rhinichthys atratulus*), golden shiners (*Notemigonus crysoleucas*) and other small minnow (*Cyprinidae*) species.

3.4.3.1.3 Estuarine and Marine Fish Species

The estuarine and marine fish species that were likely present prior to dam construction and which are still likely found at the mouth of Eel River, are presented in Table 3.4.11. Relative abundance information on each species is also provided. Most of the species indicated in Table 3.4.11 still likely move from the marine environment of Eel Bay into the estuary annually (Madden, pers. comm.).

Table 3.4.11 **Estuarine and Marine Fish Species that May Occur in the Eel River Estuary/Eel Bay**

Species	Genus/Species
Capelin	*Mallotus villosus*
Atlantic herring	*Clupea harengus harengus*
Striped bass	*Roccus saxitalis*
Three-spined stickleback	*Gasteroteus aculeatus*
Banded killifish	*Fundulus diaphanus*
Mummichog	*Fundulus heteroclitus*
Atlantic silverside	*Menidia menidia*
Long-horned sculpin	*Myxoxocephlus octodecemspinosus*
Short-horned sculpin	*Myxoxocephlus scorpius*
Atlantic Sea raven	*Hemitripterus americanus*
Thorny skate	*Raja radiata*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Atlantic mackerel	*Scomber scombrus*
White hake	*Urophycis chuss*
Atlantic cod	*Gadus morhua*
Winter flounder	*Pseuodopleuronectes americanus*
Smooth flounder	*Liopsetta putnami*
Rock gunnel	*Pholis gunnellus*
Lumpfish	*Cyclpterus lumpus*
Spiny dogfish	*Squalus acanthias*
Cunner	*Tautogolabrus adsperus*

3.4.3.2 Post-dam and Existing Conditions

3.4.3.2.1 Diadromous Fish

The American eel occurs from southwest Greenland, along the East Coast of North America to the Gulf of Mexico and is abundant in fresh and saltwaters of the Maritime Provinces. Unlike Atlantic salmon, eels migrate upstream in rivers in the spring to feed and grow, and downstream to sea in autumn to mature and spawn. Although the early life history of the American eel remains largely a mystery, some studies have suggested that the Sargasso Sea, in the southern North Atlantic, is their primary spawning ground. American eels inhabit muddy, sedimenty bottoms of lakes and are aggressive carnivores (*i.e.*, meat eaters) preying at night on a variety of fish and invertebrate species (Scott and Crossman, 1973). The American eel fishery stopped shortly after the dam was constructed. In a 2004 Resident Fish Survey in the Eel River impoundment (Table 3.4.12), one American Eel was captured.

Rainbow smelt occur in the Atlantic coastal drainage from Labrador to New Jersey. Ocean-dwelling smelt enter Maritime rivers at night in April and May to spawn. Rainbow smelt are pelagic (living off-the-bottom), schooling fish inhabiting inshore coastal waters. They are carnivorous, feeding primarily on crustaceans (Scott and Crossman, 1973). During regular observations in the Eel River area over 30 years, no smelt have been reported in the river (Madden, pers. comm.). However, the annual timing of the adult smelt migration into the Restigouche River, which is less than 5 km from Eel River, is from approximately May 3 to June 10 (Madden, pers. comm.).

American shad are found from Newfoundland and the Gulf of St. Lawrence to Florida. Shad ascend freshwater streams in the Maritimes and Quebec to spawn. Individuals have been known to travel from Virginia all the way to the Miramichi estuary in the same year for this purpose. Little is known about shad at sea except that they are schooling plankton (small or microscopic plants and animals that float or drift in great numbers in fresh or salt water) feeders, which are often preyed upon by seals. American shad are caught commercially in the Maritimes while spawning upriver. They are also esteemed game-fish in the eastern United States and are valued as well for caviar and shad-liver oil (Scott and Crossman, 1973). American shad are not as common in Chaleur Bay as they are in the Northumberland Strait and the Miramichi River estuary. However, there is a small shad spawning run in the Restigouche River, and they are taken in gill nets in the Listiguj food fishery that primarily targets Atlantic salmon (Madden, pers. comm.).

Gaspereau, a common name referring to both blueback herring and alewife, are found in coastal waters from Newfoundland to North Carolina and spawn in the freshwater streams of the Atlantic coastal drainage. Most of their adult life is spent at sea, while blueback herring spawning takes place during the spring in quiet rivers above the influence of the tide. Adults usually leave inshore waters immediately after spawning and overwinter in deeper water. Gaspereau feed primarily on zooplankton (plankton that consists of animals; mainly small crustaceans and fish larvae) such as copepods but have been known to consume plant material as well. In New Brunswick, commercial gaspereau fisheries are established in the Saint John and Miramichi Rivers, largely to supply the pet food industry (Scott and Crossman, 1973).

The peak of the alewife migration into Eel River occurs in mid-June, with the earliest fish entering in late May and the last individuals entering in early July. Counting fences operated by the NBDNR at Eel River Crossing from June 15 to September 15, 1993 collected a total of 518 alewives (Madden, pers. comm.). Thirty-three were caught on June 15, 297 on June 16, and 151 on June 17. Only 41 were counted during the remainder of June, and 14 were tallied in July. All fish were moving upstream only and there was no evidence that gasperau spawning had occurred at that time (Madden, pers. comm.). On June 15, 2004 adult alewives were observed spawning at the pump house on the Eel River impoundment (Madden, pers. comm.).

The sea lamprey is the largest and most predaceous of the lampreys. The adults live as external parasites of fishes and, possibly, other marine vertebrates. The sea lamprey is common on both sides of the Atlantic from Greenland to Florida and from Norway to Africa. Adults congregate in estuaries or rivers during late winter and spawn upstream in spring in large numbers, using their suction disc to attach to substrates in order to negotiate near-vertical barriers or rapids. Males and females both die shortly after spawning (Scott and Crossman, 1973). Sea lampreys are common in Eel River. They were frequently taken in the trap at the fish fence that was being used to monitor the sea run brook trout runs into the river in 1992 and 1993 (Madden, pers. comm.).

The Atlantic salmon is native to the North Atlantic Ocean from Iceland and Greenland, south to the Connecticut River. Atlantic salmon spawn in freshwater streams. Their progeny remain in freshwater for two to three years and then return to the sea to feed and grow for a period of one (grilse) to three or even four winters before returning to freshwater to spawn. Although salmon spawn in the autumn, they can enter freshwater from late may to mid-November. After spawning, the "kelts" remain under the river ice for the winter and return to the ocean in the spring. Salmon at sea eat a variety of marine organisms including crustaceans (krill), smelt, alewives, herring, capelin, small mackerel and small cod (Scott and Crossman, 1973).

Since the dam was constructed, most ascending adult salmon (grilse and older fish) enter the river from September 15 to November 10 each year (Madden, pers. comm.). The timing of the peak migration is correlated with water level, and occurs from September 7 to October 15 in high water years, and October 25 to November 5 in drought years (Madden, pers. comm.). Droughts have predominated since 1987. While Atlantic salmon do not currently appear to migrate into the Eel River before September, adjacent and similarly sized rivers such as the North Charlo, South Charlo, Benjamin, and Nigadoo Rivers, have grilse migrating even in July in high water years.

Salmonid counting fences were placed on the main stem of Eel River and on the river's South Branch in 1992 and 1993 (Madden, pers. comm.). In 1992, 35 adult salmon entered the river and were counted. One entered in July, five in September, and 30 were enumerated in October prior to the trap's removal on October 16 (NBDNR, 1992). Salmon were still entering the traps on the last day they operated, indicating that the count that year was incomplete. In 1993, the objective of the counting fence was to document the sea trout run, and to incidentally record the number and timing of migration of other species (Madden, pers. comm., 2005). During 1993, the trap operation commenced June 14 and terminated on September 15 and only one grilse was captured (Ross, 1993).

The Eel River is a productive salmon river relative to its size. In 1972, between mid-September and mid-November, roughly 1,000 adult salmon entered the Eel River to spawn. Their main route of access past the dam was to jump over the stop logs at high tide. Many salmon attempted to ascend through the fishway, however approximately 50 percent of the fish were repelled by the algae that was clogging the pools and the upper channel (Madden, pers. comm.). The estimate of approximately 1,000 salmon and grilse returning to a drainage area of approximately 100 km^2 (the area of Eel River basin, upstream of Eel River Crossing) compares favourably with counts to the conservation barrier pool on the upper reaches of the Northwest (NW) Miramichi, a recognized salmon river. Returns to the NW Miramichi barrier pool, which has an upstream drainage area of approximately 105 km^2, averaged 951 salmon and grilse from 1992 to 2001 (DFO, 2004).

Estimates are that approximately 50 to 100 Atlantic salmon have entered the Eel River each fall in recent years (Pelletier, pers. comm.). NBDNR (1992) also mentions a fishery for salmon that was (and may still be) prosecuted in the autumn. The fishery took advantage of delayed migration at the fishway. The methods employed included intensive gill netting, spearing and jigging. The decrease in spawning escapement that has occurred over the last 30 years in the Eel River is reflected in lower than optimal juvenile salmon densities as revealed by electrofishing counts (NBDNR, 1992 and 1993).

Sea-run brook trout are native to North America. Spawning occurs in late summer or autumn in clear, cool, well-oxygenated lake streams and lakes. Brook trout feed on virtually anything from plants to crustaceans, fish and insects. A popular game fish in eastern Canada, brook trout are often raised in hatcheries in order to stock private fishponds (Scott and Crossman, 1973).

The NBDNR operated two counting fences from June 14 to September 15, 1993, one on the main stem of Eel River and one on the river's South Branch. The total number of trout counted from both traps was greater than 1,300, with the majority (1,000+) moving up the main stem, and approximately 300 ascending the South Branch (Madden, pers. comm.). Forty-eight sea trout were counted on the first day of operation on the main stem, implying that the migration was already underway and the total number of trout moving into the river was probably considerably higher than 1,300. Timing of the migration was the same at both fences. As occurs in most, if not all streams, most of the older fish (≥ 25 cm.) moved upstream first. Of the 51 trout ≥ 25 cm that entered the main stem, 80 percent (41) arrived in June. It is likely that more large trout would have been enumerated in June had the counting fence been in full operation before June 15 (Madden, pers. comm.). The highest daily fish count occurred on July 13, when 149 trout were tallied on the main stem. The next highest counts were of 47 and 42 trout on July 2 and July 30, 1993 respectively.

Based on body length, the majority of the trout were estimated to be one and two year-olds (10 to 22 cm). Seven of the 300 South Branch trout were ≥ 25 cm (range 23 to 28 cm) were likely 3-years old fish. Only five of the 1,300 trout collected in the counting fences were ≥ 30 cm and were likely at least four years old (Madden, pers. comm.). This low number of large trout captured in the counting fences probably does not represent the true population of large trout and it is likely that the fences were not set up early enough to catch many of the larger fish. This is supported by the fact that up to 50 large trout are angled from the Eel River system annually (Madden, pers. comm.). The largest trout measured in the counting fences were 51 cm from the South Branch, and two of 44.5 cm and 46.0 cm, respectively, from the main stem. Most of the younger trout (10 to 16 cm and age 1+) began to ascend Eel River on July 2, continuing in large numbers until July 30 (Madden, pers. comm.).

While it has been reported that the annual brook trout run is now diminished compared with the pre-dam period (Lushington, pers. comm.), other observations contend that Eel River has the most productive recreational fishery for sea-run brook trout in terms of numbers caught, of all streams between the Caraquet River and the Restigouche River (Madden, pers. comm.).

The Atlantic tomcod spawns in the winter usually beneath ice cover in shallow, gravelly streams and estuaries. Although one of the smaller species in the cod family, it is a voracious predator feeding on crustaceans, worms, mollusks, squid and fish (Scott and Crossman, 1973). Presently, some tomcod are caught near the downstream side of the dam, but generally they are fished further out in Eel Bay (ERBFN, 2005b).

3.4.3.2.2 Fish Resident in the Impoundment

The Eel River impoundment is a slow moving waterbody approximately 3 km long and averaging 300 m wide. The impoundment is shallow and does not thermally stratify in the summer or winter. The impoundment provides habitat for several resident fish species. To determine what fish species were resident in the impoundment, four fyke nets (long, bag-shaped nets held open by hoops) were set on August 17, 2004 and left fishing for 24 hours. Water temperatures were at maximum in the impoundment at this time of year. The traps were installed at four locations (Figure 3.4.12):

- Site 1 – near the mouth of the southeast inlet near the dam;
- Site 2 – 120 m upstream of confluence of Black Brook and Eel River;
- Site 3 – 100 m upstream of station U4, and set in the channel fishing in an upstream direction; and
- Site 4 – In the same area as Site #3 but attached to shore and fishing in both the upstream and downstream direction.

The results of the survey are provided in Table 3.4.12. White sucker and the yellow perch are the dominant resident fish species in the impoundment in the summer.

Table 3.4.12 Results of 2004 Resident Fish Survey in the Eel River Impoundment

Site	Species	# Captured	Length Range (cm)
1	White sucker	6	14 to 47.2
	Red belly dace	1	5.2
	Banded killifish (*Fundulus diaphanus*)	1	4.4
	4-Spine stickleback	1	2.6
	Gaspereau	8	5.1 to 6.1
2	White sucker	70	11 to 47.5
	Golden shiner	12	10.2 to 19.0
	Yellow perch	33	14.1 to 24.5
3	White sucker	103	12.6 to 46.2
	Yellow perch	10	14.5 to 21.0
	American eel	1	75
4	White sucker	9	14.2 to 23.2
	Yellow perch	70	13.5 to 25.5
	Golden shiner	43	7.9 to 12.6

3.4.3.2.3 Aquatic Species of Special Conservation Concern

The southern Gulf of St. Lawrence population of striped bass (*Morone saxatilis*) was listed as Threatened by COSEWIC in November 2004. The only known active spawning location for striped bass in New Brunswick is in the NW Miramichi River estuary (Bradford *et. al*., 2001). The Eel River estuary could provide potential rearing habitat for striped bass where they would forage on small fish and invertebrates, though this has not been observed.

The summer range of this population extends from Percé, QC, to the Margaree River in Cape Breton (Bradford *et. al*., 2001). The spawning population has ranged from a low of 3,400 fish in 1998 to 50,000 in 1995. The current spawning population stands at 20,000 bass (Chaput, pers. comm.). The provisional conservation-spawning requirement for females is 5,000 striped bass (Bradford and Chaput, 1996). The species has supported small, locally popular, recreational fisheries and commercial fisheries, which were unregulated until 1996 (Bradford et. al., 2001).

The NBDNR lists the following aquatic species of special conservation concern under their General Status of Wildlife in New Brunswick.

The brook floater (*Alasmidonta varicosa*) is in NBDNRs May be at Risk category. This mollusc species has a global G3 status implying that it is at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors (NatureServe, 2005). It has a status in New Brunswick of S1 (*Critically Imperiled*) (NatureServe, 2005). The species lives in riffle habitat of streams, therefore if the species were present in the Eel River drainage basin, it would be located well upstream of the Assessment Area. However, it is not known if this species is present in the Assessment Area.

The triangle floater (*Alasmidonta undulata*) is in NBDNRs Sensitive category. It has a global G4 status, which implies that it is uncommon but not rare; with some cause for long-term concern due to declines or other factors (NatureServe, 2005). It has a status of S2 (*Imperiled*) in New Brunswick (NatureServe, 2005). Triangle floaters are immobile as adults and live in substrate composed of gravel, sand and mud in slow-moving, small streams. If they inhabit Eel River, the impoundment would likely provide suitable habitat.

The Atlantic salmon is in NBDNRs May be at Risk category. The population of salmon in Eel River is not as large as it has been historically, however with an annual adult spawning recruitment of several hundred individuals (Madden, pers. comm.), the species is not at immediate risk of extirpation.

3.5 Terrestrial Environment

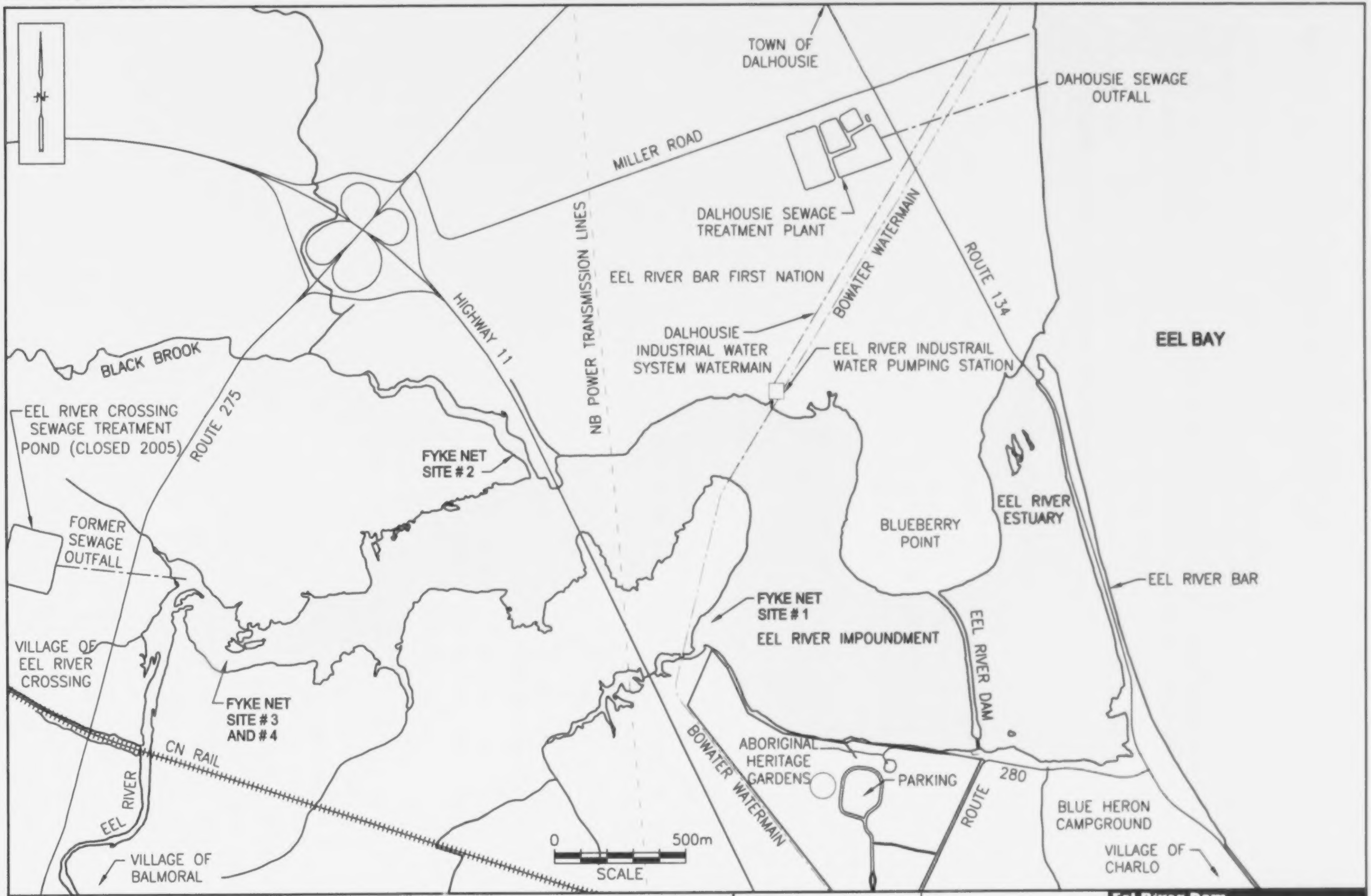
3.5.1 Wetlands and Riparian Vegetation

Wetlands and riparian vegetation includes the Eel River impoundment and all wetlands and shorelines connected to it, as well as the estuarine area between the dam and Route 134. Information on both historical and recent conditions was available from several previous environmental reports (BMA and CG&S, 2000; Hood and Associates, 2000) and a field survey of wetland resources and plant Species at Risk and Species of Conservation Concern in the area of Eel River dam was conducted on August 11 and 12, 2004. Surveys were conducted both on foot and from canoe.

Species at Risk are considered to be all species listed under Schedule 1 of the *Canadian Species at Risk Act* (*SARA*) and/or species listed under the New Brunswick *Endangered Species Act*. The potential for Species at Risk to be present is discussed in Section 3.7.

Species of Conservation Concern include all species assigned special status by the Atlantic Canada Conservation Data Centre (*i.e.,* S1 to S3) and by NBDNR in the General Status List. These are described in detail in Section 3.7.

FILE: 15830\EIA REPORT\FYKE


N
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
EEL RIVER BAR FIRST NATION
NB POWER TRANSMISSION LINES
BOWATER WATERMAIN
ROUTE 134
HIGHWAY 11
EEL BAY
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
BLACK BROOK
ROUTE 275
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
FYKE NET SITE # 2
EEL RIVER ESTUARY
BLUEBERRY POINT
FORMER SEWAGE OUTFALL
EEL RIVER BAR
FYKE NET SITE # 1
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
VILLAGE OF EEL RIVER CROSSING
FYKE NET SITE # 3 AND # 4
CN RAIL
BOWATER WATERMAIN
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
BLUE HERON CAMPGROUND
EEL RIVER
VILLAGE OF BALMORAL
0
500m
SCALE
VILLAGE OF CHARLO

FYKE NET LOCATIONS ON EEL RIVER AUGUST 2004

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 3.4.12

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

3.5.1.1 Pre-dam Conditions

Pre-dam wetland in the Eel River estuary was saltwater marsh, flooded twice daily by the tides, and described by local hunters as full of pools, hidden channels, and tall marsh grasses (Figure 3.5.1). According to Boissonnault McGraw Associates and CG&S (2000), comparison of pre-dam aerial photos with current conditions indicate that former saltmarsh and floodplain shorelines were composed of much larger emergent wetland areas than are present today. Examination of historic aerial photos indicate that approximately 85 ha of saltmarsh habitat was present in the estuary. The species characteristics are not known due to the absence of data.

3.5.1.2 Post-dam and Existing Conditions

Based on available mapping, aerial photos and field surveys of wetland resources in August, 2004, several freshwater marshes were identified along the impoundment margin, totalling approximately 66 ha in area (Figure 3.5.2). A small area of salt marsh (approximately 1 ha) was also identified in the estuarine area between the dam and Route 134 (*i.e.*, the estuary below the dam).

Wetland areas within the impoundment are uniform and may be treated as one single wetland in which the hydrology is controlled by the level of water in the impoundment. Emergent vegetation is dominated by deep marsh plants such as cattails (*Typha sp.*), sedges (*Carex sp.*, *Schoenoplectus acutus*), bur-reed (*Sparganium sp.*), and flowering rush (*Botomus umbellatus*). There are small areas covered with shrubs such as alders (*Alnus sp.*), willow (*Salix sp.*) and sweetgale (*Myrica gale*). The freshwater marshes along the river support populations of marsh birds while the area below the dam is essentially marine shorebird habitat. The freshwater wetland is considered an integral part of the popular walking trail along the south side of the impoundment. There are several lookouts onto the marsh and birdwatchers frequent the area.

Large amounts of floating-leaved aquatic plants are present in the deepwater areas of the impoundment. Waterweed (*Elodea canadensis*) is found in open water between clumps of flowering rush and pondweed (*Potomogeton sp.*) is abundant throughout the impoundment. In recent years, there has been an apparent increase in algal growth that is very dense by late summer. The river is reduced to a very narrow channel in the upper reaches of the impoundment and most of the lower impoundment is covered in algal growth (Lushington, pers. comm.). The aquatic plant water-milfoil (*Myriophyllum alterniflorum*) is also very common in dense patches and is considered to indicate a nutrient enriched condition in the impoundment (Hood and Associates, 2000). This conclusion is also supported by the large growth of algae during mid- to late summer.

The existing saltmarsh, which has formed in the estuary between the dam and Route 134, has apparently developed on an area of increasing sediment buildup noted to have occurred since the dam was constructed (Hood and Associates, 2000). This small area is composed of high and low saltmarsh with many tidal pools and has not been identified on previous wetland mapping (New Brunswick Wetland Atlas, 1987). High saltmarsh is dominated by salt-meadow cord grass (*Spartina patens*) and low saltmarsh is dominated by saltwater cord grass (*Spartina alterniflora*). The presence of numerous tidal pools adds to the overall value for wildlife. The relatively small size and nearness to roadways and other human activities somewhat reduces overall value to wildlife.

3.5.1.3 Vascular Plant Species of Conservation Concern

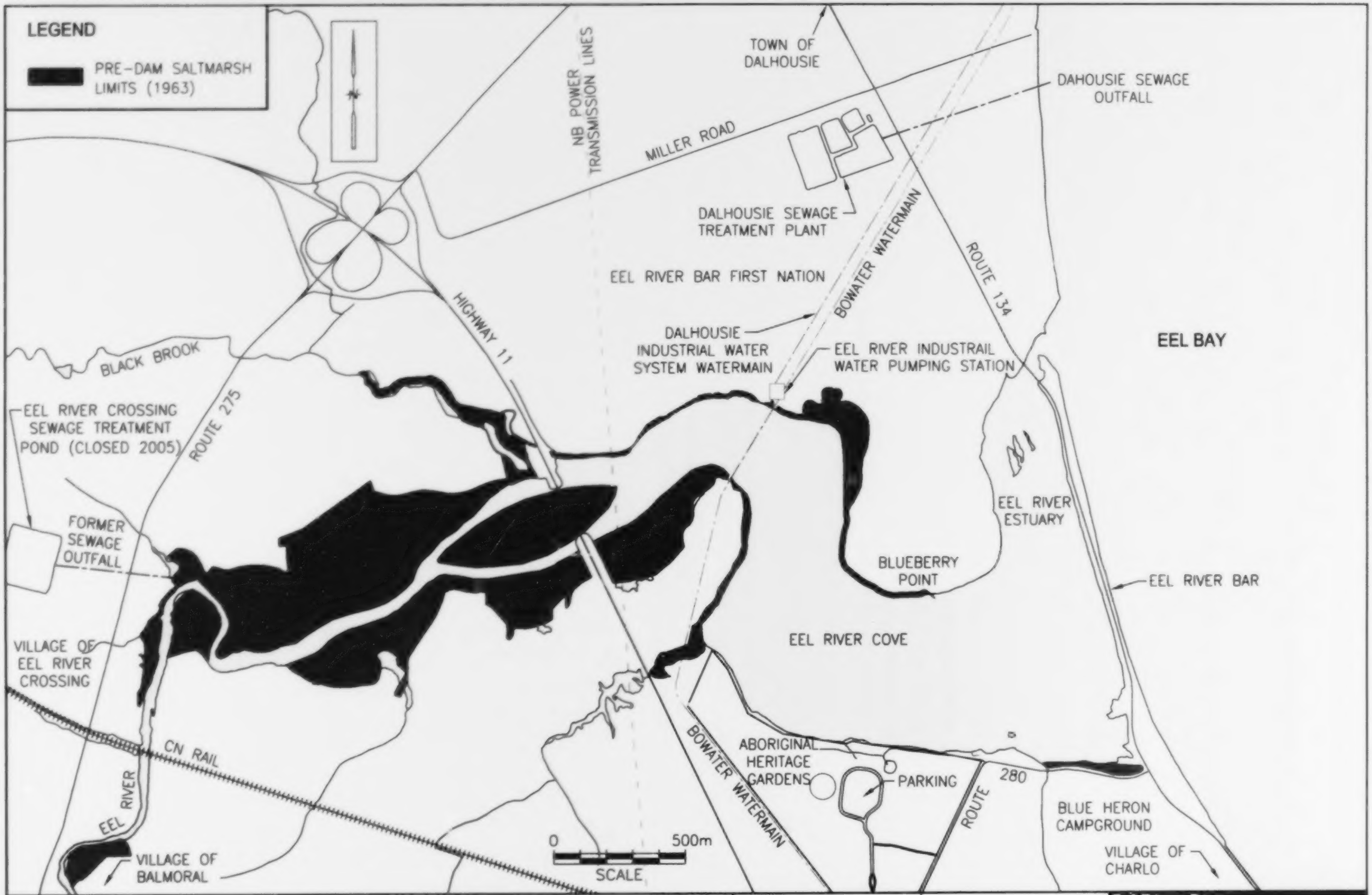
The Atlantic Canada Conservation Data Centre (AC CDC) assigns provincial status rarity ranks to Species of Conservation Concern in the region ranging from Extremely Rare to Common through a series "S-ranks", as described in Table 3.5.1 below. The NBDNR assigns general status ranks to Species of Conservation Concern ranging from At Risk to Secure.

Table 3.5.1 Definitions of AC CDC Rarity Ranks and NBDNR General Status Ranks

AC CDC Ranks Definitions (AC CDC 2003)	
S1	Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant at some locations. (21 to 100 occurrences).
S4	Usually widespread, fairly common throughout its range in the province, and apparently secure with many occurrences, but the species is of long-term concern (*e.g.*, watch list). (100 + occurrences).
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (*e.g.*, S1S2)
NBDNR General Status Rankings Definitions (NBDNR 2003)	
At Risk	Species for which a formal assessment has been completed, and determined to be at risk of extirpation or extinction. To be described by this category, a species must be either listed as Endangered or Threatened under *SARA* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), or as Endangered or Regionally Endangered under the New Brunswick *Endangered Species Act* and accompanying regulations.
May Be At Risk	Species or populations that may be at risk of extirpation or extinction, and are therefore candidates for a detailed risk assessment.
Sensitive	Species which are not believed to be at risk of extirpation or extinction, but which may require special attention or protection to prevent them from becoming at risk.
Secure	Species that are not believed to be At Risk, May Be At Risk, or Sensitive. These were generally species that were widespread and/or abundant. Although some Secure species may be declining, their level of decline was not felt to be a threat to their status in the province.

Six rare or uncommon species were encountered during the August 2004 survey (Table 3.5.2 and Figure 3.5.2). None of the vascular plant species recorded were listed as At Risk by NBDNR, or listed as Threatened or Endangered by the federal *Species at Risk Act* (*SARA*) or the New Brunswick *Endangered Species Act*. The AC CDC listed one plant species found at Eel River as S1, two species as S2, two as S3, and one as S3S4. Each of these species is described in detail below.

FILE: 15830\EIA REPORT\SALTMARSH-PRE-DAM


LEGEND
▬ PRE-DAM SALTMARSH LIMITS (1963)
NB POWER TRANSMISSION LINES
MILLER ROAD
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
DALHOUSIE SEWAGE TREATMENT PLANT
BOWATER WATERMAIN
ROUTE 134
EEL RIVER BAR FIRST NATION
HIGHWAY 11
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
EEL BAY
BLACK BROOK
ROUTE 275
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
FORMER SEWAGE OUTFALL
EEL RIVER ESTUARY
BLUEBERRY POINT
EEL RIVER BAR
EEL RIVER COVE
VILLAGE OF EEL RIVER CROSSING
CN RAIL
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
BLUE HERON CAMPGROUND
EEL RIVER
BOWATER WATERMAIN
0
500m
SCALE
VILLAGE OF BALMORAL
VILLAGE OF CHARLO

LOCATIONS OF SALT MARSHES DELINEATED FROM 1963 AERIAL PHOTOGRAPHY OF THE EEL RIVER ESTUARY

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 3.5.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

Table 3.5.2 Plant Species Recorded During the August 2004 Survey

Scientific Name	Common Name	AC CDC S-rank	New Brunswick General Status Rank
Ranunculus sceleratus	Cursed crowfoot	S1	May be at Risk
Carex recta	Salt-marsh sedge	S2	Sensitive
Spirodela polyrrhiza	Common water-flaxseed	S2	Secure
Carex diandra	Lesser panicled sedge	S3	Secure
Equisetum palustre	Marsh horsetail	S3	Secure
Lysimachia thyrsiflora	Tufted loosestrife	S3S4	Secure

Cursed crowfoot is listed as Extremely Rare (S1) by the AC CDC and by NBDNR as May Be At Risk. It is typically found in wet ditches, in low, damp ground and along the upper edge of salt marshes in muddy to sandy, sometimes disturbed soils (Hinds, 2000; UNB Herbarium). This collection is part of the few northern-most occurrences of this species, first identified near the River Charlo, Restigouche County by Fowler in 1874 (Hinds, 2000). This species also occurs in southern New Brunswick near the Town of Milltown and the St. Croix River Valley, as well as locally in the City of Fredericton where it has colonized a few domestic gardens (UNB Herbarium). The continental range of cursed crowfoot stretches to Alberta, Manitoba and Quebec where it is ranked by COSEWIC as Not at Risk, and also less frequently into the southern United States (Natureserve, 2005).

Salt-marsh sedge is listed as Very Rare (S2) by the AC CDC and by NBDNR as Sensitive (AC CDC, 2003; NBDNR, 2003). It is found along the coast in salt marshes, brackish shores and coastal bogs. Salt-marsh sedge has also been collected from coastal regions in New Brunswick, including Gloucester, St. John, Charlotte and Kent counties, and is also commonly found in Ontario, Nova Scotia and, less commonly, in New England (UNB Herbarium; Natureserve, 2005).

Lesser panicled sedge is listed as Uncommon (S3) by the AC CDC and as Secure by NBDNR (AC CDC, 2003; NBDNR, 2003). It is found primarily in bog and fen lowlands. Lesser panicled sedge has a broad distribution across North America occurring from Alaska to Newfoundland and south to California and New Jersey. It is also known to occur in both Europe and Asia (Natureserve, 2005). In New Brunswick, the sedge is recorded from scattered sites along the northern and eastern coastlines and from parts of Carleton, Victoria, and Restigouche counties (UNB Herbarium). Collections continue to be made throughout many other regions in the province suggesting this species is more common than currently documented.

Marsh horsetail is listed as Uncommon (S3) by the AC CDC and as Secure by NBDNR (AC CDC, 2003; NBDNR, 2003). It is usually found in marshes and calcium-rich, shaded seepy gravels (Hinds, 2000). Collections of this species have been made from the Fredericton municipality and from the mouth of the Eel River near the Town of Dalhousie (UNB Herbarium). Marsh horsetail is widely distributed across southern Canada but is generally poorly distributed in the United States (Natureserve, 2005).

Water loosestrife is listed as Uncommon to Fairly Common (S3S4) by the AC CDC and as Secure by NBDNR (AC CDC, 2003; NBDNR, 2003). It is found in swamps, wet thickets and bogs. Commonly found in the central and western provinces, this species has been only occasionally collected in New Brunswick from lowland areas such as the Tantramar and Jolicure marshes and the Miramichi River (UNB Herbarium).

Common water-flaxseed is ranked as Very Rare (S2) by the AC CDC and as Secure by NBDNR (AC CDC, 2003; NBDNR, 2003). This species is a floating aquatic plant found in quiet, slow-moving freshwaters and borders of streams. In New Brunswick, it has been collected along the St. John, St. Croix and Eel Rivers (Hinds, 2000). It is commonly found in its preferred habitat throughout the rest of Canada and much of the United States (Natureserve, 2005).

Additionally, identified as a Species of Special Concern by New Brunswick, *Arabis divaricarpa* was seen on the rocky shoreline at the mouth of Eel River. This location is outside the impoundment and there is no potential pathway between the Project and this plant species.

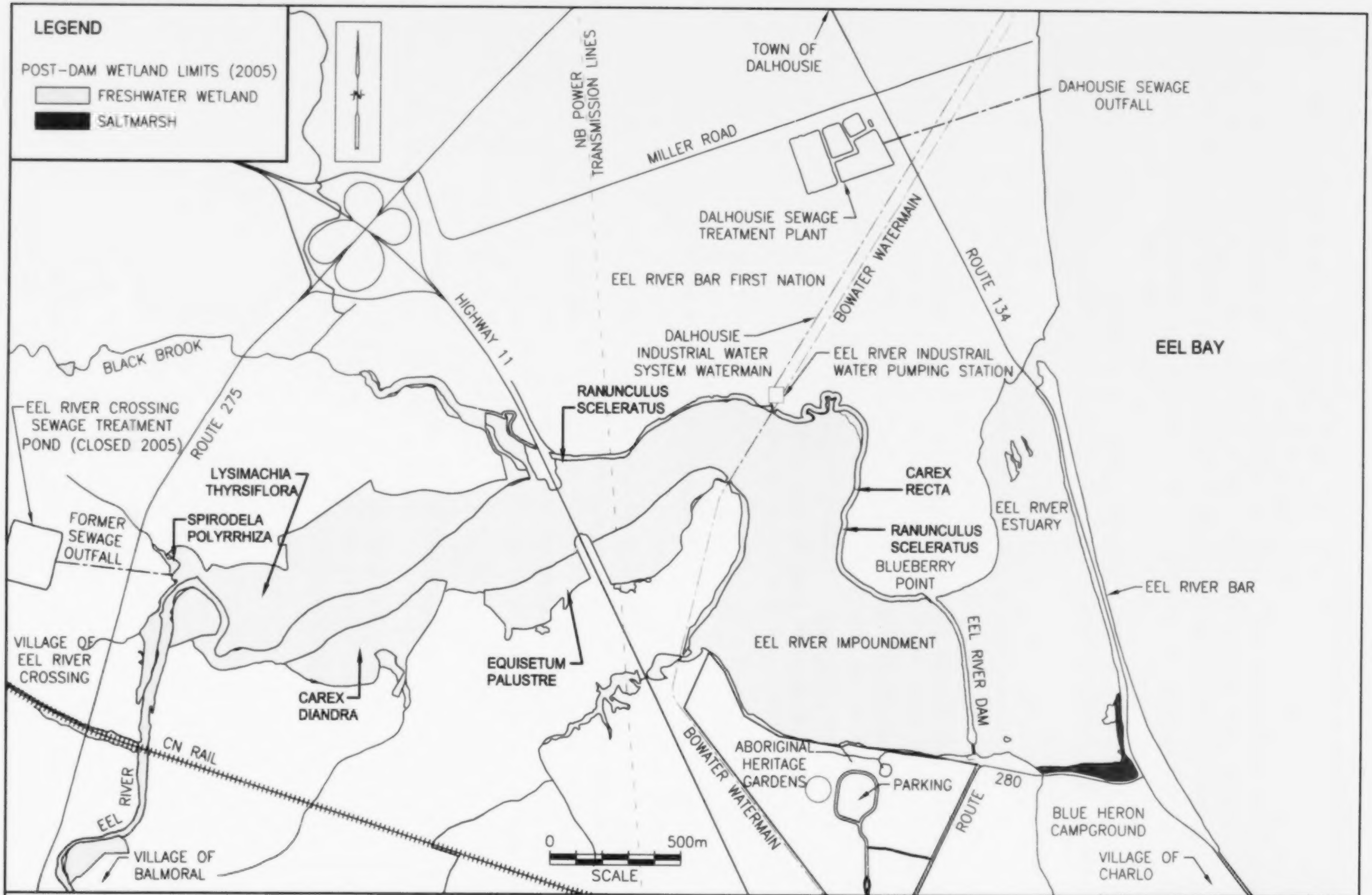
The AC CDC database was queried to identify any additional plant Species of Conservation Concern that may be present within 5 km of the Eel River dam (Appendix C). This list draws upon data from current and historical sources but is not necessarily comprehensive because the database is incomplete and because data is inherently out of date (*i.e.*, data within the database represents past conditions when the data was obtained). The precision values describe the degree of precision possible in describing the location of that species and range from 1.0 (less than 5 m), 3.0 (within approximately 1 km), to 4.0 (approximately 50 km) and beyond.

Only five species identified through the AC CDC query, and not already included in the results of the 2004 survey, are of potential concern with respect to the Project. These species are included here either because the location information shows them to be generally within a few km of Eel River or the preferred habitat of the species may be present in the area. These species include:

- coast-blite goosefoot (*Chenopodium rubrum*) (S2) – coastal, salt-loving species growing on beaches and sometimes saltmarshes;
- Frankton's saltbush (*Atriplex franktonii*) (S2) – also coastal, salt-loving species growing on beaches and sometimes saltmarshes;
- sago false pondweed (*Stuckenia pectinata*) (S2) – brackish, alkaline-loving aquatic species;
- common water-milfoil (*Myriophyllum sibiricum*) (S2) – freshwater, alkaline-loving aquatic species; and
- blunt-leaf bedstraw (*Galium obtusum*) (S1) – freshwater shoreline species.

Tables C.1 and C.2 (Appendix C) provide a plant species lists for the freshwater impoundment and the saltmarsh downstream from the dam.

FILE: 15830\EIA REPORT\SALTMARSH-POST


LEGEND
POST-DAM WETLAND LIMITS (2005)
FRESHWATER WETLAND
SALTMARSH
N
NB POWER TRANSMISSION LINES
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
BOWATER WATERMAIN
ROUTE 134
EEL RIVER BAR FIRST NATION
HIGHWAY 11
EEL BAY
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
BLACK BROOK
ROUTE 275
RANUNCULUS SCELERATUS
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
LYSIMACHIA THYRSIFLORA
CAREX RECTA
EEL RIVER ESTUARY
FORMER SEWAGE OUTFALL
SPIRODELA POLYRRHIZA
RANUNCULUS SCELERATUS
BLUEBERRY POINT
EEL RIVER BAR
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
VILLAGE OF EEL RIVER CROSSING
EQUISETUM PALUSTRE
CAREX DIANDRA
CN RAIL
BOWATER WATERMAIN
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
EEL RIVER
BLUE HERON CAMPGROUND
0
500m
SCALE
VILLAGE OF BALMORAL
VILLAGE OF CHARLO

LOCATIONS OF RARE VASCULAR PLANTS AND MARSHES IDENTIFIED IN AUGUST 2004 AND DELINEATION OF POST-DAM MARSHES FROM AUGUST 2005 AERIAL PHOTOGRAPHY OF THE EEL RIVER IMPOUNDMENT AND ESTUARY

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 3.5.2

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

Invasive Plant Species

Three invasive plant species were identified during the August 2004 survey of the Eel River dam area. Two of these plants, purple loosestrife (*Lythrum salicaria*) and flowering rush (*Butomus umbellatus*), tend to dominate and displace wetland habitats. The purple loosestrife tends to be concentrated near travel routes, while the flowering rush has become the dominant shoreline vegetation in most of the lower impoundment. The third invasive species identified, reed canary grass (*Phalaris arundinacea L.*), is also quite dominant in the floodplain of the upper impoundment.

3.5.2 Wildlife

3.5.2.1 Pre-dam Conditions

In 1961 the Eel River watershed was mainly forested. There was approximately 13 km^2 of improved farmland in the area, located mainly in the district of Balmoral, with some present in the Eel River district. Although there are no data available, it is likely that all wildlife species typical of northern New Brunswick were present in the Assessment Area, depending upon the available habitat locally. Of particular interest are muskrats (*Ondatra zibethica*) due to a large population currently found in the impoundment. Apparently muskrats were always present along Black Brook prior to dam construction (Clifford, pers. comm.) and white-tailed deer (*Odocoileus virginianus*) inhabited the area (BMA and CG&S, 2000).

3.5.2.2 Post-dam and Existing Conditions

Around most of the impoundment, there is a thin buffer of forested area composed of mixed hardwood and softwood, primarily poplar (*Populus balsamifera*) and balsam fir (*Abies balsamea*). Along the southern boundary of the impoundment are areas of dense softwood consisting of black spruce (*Picea mariana*), balsam fir, and eastern white cedar (*Thuja occidentalis*). Currently, new timber harvesting has occurred south of the impoundment and both agricultural and silvicultural activities take place around its northern edge.

Furbearers found in the watershed include red fox (*Vulpes vulpes*), coyote (*Canis latrans*), mink (*Mustela vison*), muskrat, raccoon (*Procyon lotor*), beaver (*Castor canadensis*), otter (*Lontra canadensis*), fisher (*Martes pennanti*), ermine (weasel) (*Mustela erminea*), and red squirrel (*Tamiasciurus hudsonicus*). All of these species, with the exception of fisher, ermine and red squirrel, have been observed in the impoundment area. Most of these species are of limited economic importance and their populations are stable in the Province.

Dense populations of muskrat are reported in the impoundment, where essentially stable water levels and cattails provide suitable habitat. A muskrat hut was recorded at the center of a large trail network during field surveys in 2004. Muskrat trapping occurs in the area. There were also signs of occasional habitation by beavers, including cuttings and old beaver lodges and dams. Beavers appear to be currently limited to Black Brook and the small unnamed tribuary opposite it to the south. As well, based on field observations in 2004, existing wetland and terrestrial habitat in and around the impoundment continues to support white-tailed deer.

3.5.2.3 Wildlife Species of Conservation Concern

No wildlife Species of Conservation Concern are known to inhabit the impoundment or surrounding terrestrial habitats (BMA and CG&S, 2000; Hood and Associates, 2000).

3.6 Migratory Birds

3.6.1 Pre-dam Conditions

Prior to construction of the Eel River dam, a saltwater marsh was located on the north side of Eel River, immediately west of Black Brook. This area was a popular site for waterfowl hunting (Reinsborough, pers. comm.; Clifford, pers. comm.). The marsh did not exhibit large changes in depth between tides although it was full of pools and hidden channels. The marsh vegetation was tall enough to allow hunters to stalk on waterfowl (Clifford, pers. comm.). The species that were hunted were American Black Duck (*Anas rubripes*) and Green-winged Teal (*Anas crecca*) with the occasional "unknown" duck also hunted (Reinsborough, pers. comm.; Clifford, pers. comm.). Eel River provided a steady supply of birds even though a large number of hunters frequented the river along both sides of its reach (Reinsborough, pers. comm.).

On Eel River, just above the mouth of Black Brook, there was an island that was mostly flooded at high tide and only accessible at low tide when wearing hip waders. The island was approximately 200 m long and 50 m wide. Hundreds of Wilson's Snipe (*Gallinago delicate*) foraged on the island during the hunting season, which opened October 1. There were also "lots" of Snipe in the marsh (Clifford, pers. comm.). Species never seen in the area in the fall included Brant (*Branta bernicla*), Mallard (*Anas platyrhynchos*), or Wood Duck (*Aix sponsa*). However, there were unidentified "fish" ducks seen in the area (Clifford, pers. comm.).

Canada Goose (*Branta canadensis*) would likely have been present during migration. Other migratory bird species that would likely have bred in the salt marshes of Eel River include American Black Duck, Green-winged Teal, American Widgeon (*Anas Americana*), Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*), Savannah Sparrow (*Passerculus sandwichensis*), Bank Swallow (*Riparia riparia*), and Belted Kingfisher (*Ceryle alcyon*). Although it was noted by a local resident that Mallard ducks had never been observed in the Eel River area where he hunted, it is likely that this species nested in the area and was present during migration. It is also likely that American Crow (*Corvus brachyrhyncos*) would have used the former mudflats for foraging and Common Merganser (*Mergus merganser*) may have been attracted to the river channel during migration.

Numerous shorebirds would also likely have used the mudflats during migration, including Lesser Yellowlegs (*Tringa flavipes*), Semipalmated Sandpiper (*Calidris pusilla*), Semipalmated Plover (*Charadrius semipalmatus*), Black-bellied Plover (*Pluvialis squatarola*), Greater Yellowlegs (*Tringa melanoleuca*), Least Sandpiper (*Calidris minutilla*), Spotted Sandpiper (*Actitus macularia*), Wilson's Snipe, and Short-billed Dowitcher (*Limnodromus griseus*).

3.6.2 Post-dam and Existing Conditions

A survey of the number and species of birds using the wetted area of Eel River impoundment was conducted from a non-motorized canoe in June 2004. The survey route began at the south end of the dam, followed the south shore upstream to the forks of the South and Main Eel Rivers at the Village of Eel River Crossing, continued downstream along the north shoreline to the dam and ended at the starting point.

The survey area was divided into the following seven geographical areas (Figure 3.6.1):

- south side only, from dam to and including the cove split by Highway 11;
- south side only, from above-noted cove to Highway 11 bridge;
- south side only, from Highway 11 bridge to the site where the impoundment becomes extremely narrow;
- mouth of that narrow channel upstream to the Forks of the South Eel and Main Eel River in the Village of Eel River Crossing;
- mouth of the narrow channel downstream along the north side of the impoundment to the mouth of Black Brook;
- Black Brook upstream to a point where its flow is fast.; and
- north shoreline only, from mouth of Black Brook to the north side of the dam, along the dam, and ending at the starting point.

Following the survey of the impoundment, a survey for birds was also conducted at the estuary below the dam, less than a kilometre downstream from the dam (Figure 3.6.1).

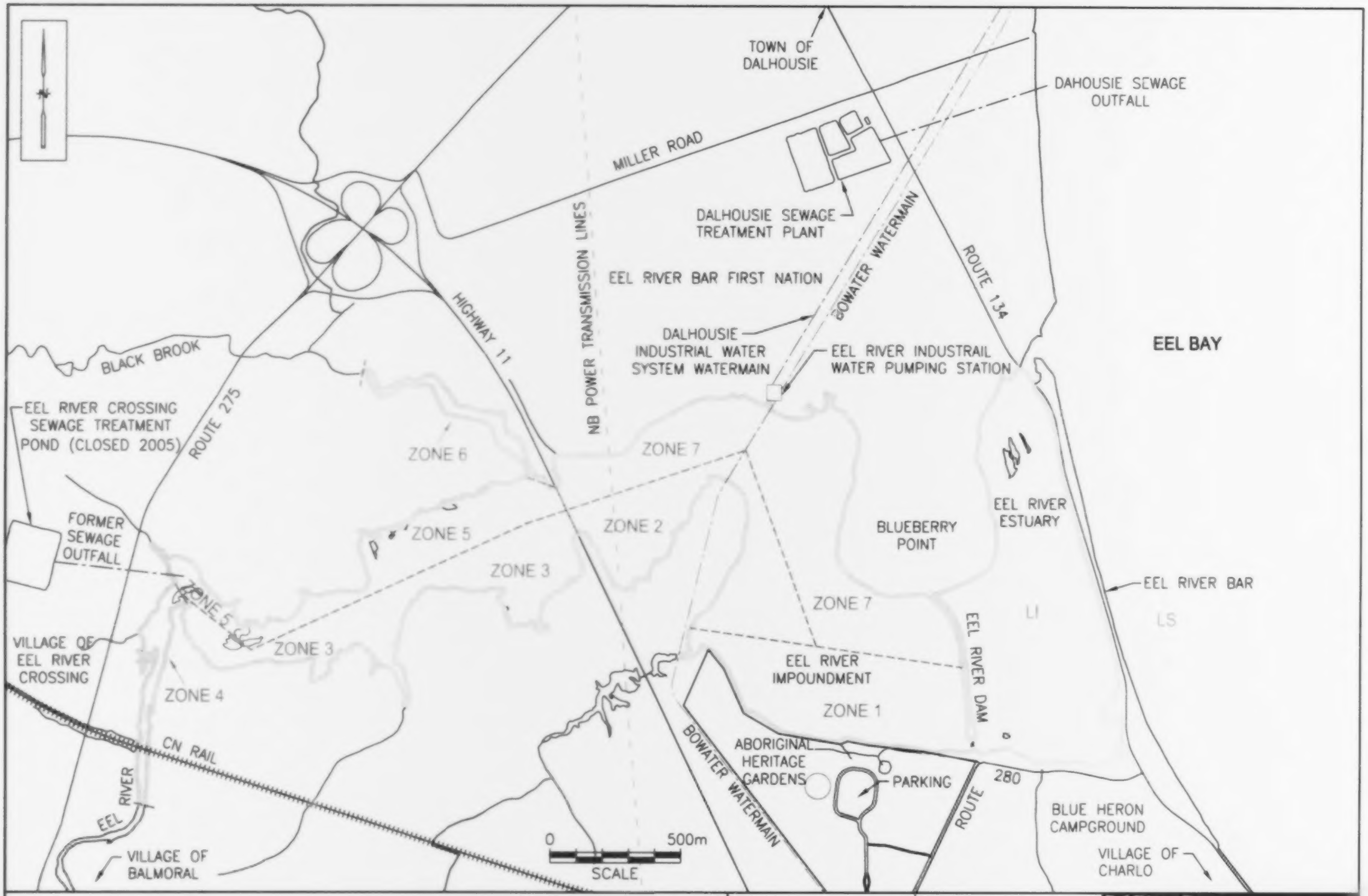
A total of 21 bird species using the shoreline (including the near-shore riparian zone), marshes and open water of the impoundment were observed or heard during the survey. While Tree Swallows (*Tachycineta bicolor*) and Barn Swallows (*Hirundo rustica*) were observed during the survey, total numbers observed were not recorded due to the probability of counting the same birds more than once as they are very mobile and were flying rapidly around the area. Also, the total number of Northern Waterthrush (*Seiurus noveboracensis*), common among the alders in the riparian zone, were not recorded. The species observed or heard during the survey are provided in Table 3.6.1

Table 3.6.1 **Results of Migratory Bird Survey at Eel River Impoundment, June 2004**

Species Heard or Observed	Total Number Recorded
American Widgeon	20
Ring-necked Duck (*Aythya collaris*)	17
Mallard	5
American Black Duck	3
Green-winged Teal	2
Blue-winged Teal (*Anas discors*)	2
Common Merganser	1
American Bittern (*Botaurus lentiginosus*)	4
Great Blue Heron (*Ardea herodias*)	7
Virginia Rail (*Rallus limicola*)	1
Sora (*Porzana Carolina*)	4
Spotted Sandpiper	6
Common Loon (*Gavia immer*)	19
Pied-billed Grebe (*Podilymbus podiceps*)	1
Double-crested Cormorant (*Phalacrocorax auritus*)	1
Red-winged Blackbird (*Agelaius phoeniceus*)	36
Swamp Sparrow (*Melospiza Georgiana*)	5
Osprey	5
Tree Swallow	Observed but not recorded
Barn Swallow	Observed but not recorded
Northern Waterthrush	Observed but not recorded

Another migratory bird survey was conducted during the month of September 2005 for characterization of fall migrants. The areas surveyed in the spring survey were re-surveyed in September 2005. Table 3.6.2 below summarizes the species heard or observed in September 2005 and Figure 3.6.1 illustrates the locations.

FILE: 15830\EIA REPORT\ZONES


TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
BOWATER WATERMAIN
ROUTE 134
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
HIGHWAY 11
EEL BAY
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
BLACK BROOK
ROUTE 275
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
ZONE 6
ZONE 7
FORMER SEWAGE OUTFALL
ZONE 5
ZONE 2
EEL RIVER ESTUARY
BLUEBERRY POINT
ZONE 3
ZONE 5
ZONE 7
EEL RIVER BAR
LI
LS
VILLAGE OF EEL RIVER CROSSING
ZONE 3
EEL RIVER DAM
EEL RIVER IMPOUNDMENT
ZONE 4
ZONE 1
CN RAIL
BOWATER WATERMAIN
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
EEL RIVER
BLUE HERON CAMPGROUND
0
500m
SCALE
VILLAGE OF BALMORAL
VILLAGE OF CHARLO

MIGRATORY BIRDS SURVEY ZONES IN 2004 AND 2005 IN THE EEL RIVER IMPOUNDMENT, ESTUARY AND BAY

Date: 2006 03 31	Scale: 1 : 20 000	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT
Job No.: 15830	Fig. No.: 3.6.1	NBDSS PROJECT No. YR101A

Table 3.6.2 Results of Migratory Bird Survey, September 2005

		Area[1] and Numbers Observed								
Common Name	**Scientific Name**	**L-I**	**L-S**	**Z-1**	**Z-2**	**Z-3**	**Z-4**	**Z-5**	**Z-6**	**Z-7**
Cormorants										
Double-Crested Cormorant	*Phalacrocorax auritus*	19		1	1	1	1			
Waterfowl										
Mallard	*Anas platyrhynchos*	4								1
Black Duck	*Anas rubripes*	104	2		2	1	1			3
Common Merganser	*Mergus merganser*	1								
Hooded Merganser	*Lophodytes cucullatus*	4	2	1						
Blue-Winged Teal	*Anas discors*						19	1		
Green-Winged Teal	*Anas crecca*					4				
Bufflehead	*Bucephala albeola*		2							
Common Goldeneye	*Bucephala clangula*	1	5		1					
American Widgeon	*Anas americana*	1		3	18	2				
Ring-Necked Duck	*Aythya collaris*			2	5				6	1
Lesser Scaup	*Aythya affinis*				15			31		2
Wood Duck	*Aix sponsa*					13			2	
Canada Goose	*Branta canadensis*	4								
Gulls										
Herring Gull	*Larus argentatus*	1	1							
Ring-Billed Gull	*Larus delawarensis*	44	1				1			
Bonaparte's Gull	*Larus philadelphia*		14							
Great Black-Backed Gull	*Larus marinus*		10							
Shorebirds and Waders										
Great Blue Heron	*Ardea herodias*	13		1	1					
American Bittern	*Botaurus lentiginosus*				1					
Sanderling	*Calidris alba*	19	5							
Greater Yellowlegs	*Tringa melanoleuca*	3	2		1					
Black-Bellied Plover	*Pluvialis squatarola*	12								
Piping Plover	*Charadrius melodus*	1	1							
Raptors										
Osprey	*Pandion haliaetus*	1	1	1						
Bald Eagle	*Haliaeetus leucocephalus*				1					
Northern Harrier	*Circus cyaneus*							1		
Sharp-Shinned Hawk	*Accipiter striatus*							1		
Songbirds										
Belted Kingfisher	*Ceryle alcyon*	1		1						
Red-Winged Blackbird	*Agelaius phoeniceus*						1		1	
Song Sparrow	*Melospiza melodia*			1						
White-Throated Sparrow	*Zonotrichia albicollis*			1						
	Species Richness	**17**	**12**	**9**	**10**	**5**	**5**	**4**	**3**	**4**
	Abundance	**233**	**46**	**12**	**46**	**21**	**23**	**34**	**9**	**7**

[1] Z-1 - Lowermost Impoundment
Z-2 - South Shore West of Highway 11
Z-3 - South Shore East of Highway 11
Z-4 - Uppermost Impoundment
Z-5 - North Shore East of Highway 11
Z-6 - Black Brook Impoundment
Z-7 - North Shore West of Highway 11
L-I - Estuary below the Dam
L-S - Seaside of the Eel River bar

Historical Christmas Bird Count (CBC) data were used to identify species present during the winter months. There have been data collected for this area in the CBC every winter for approximately the past 15 years. No unexpected species are present in the winter months, as the area is very iced over

(Lushington, pers. comm.). Additional migratory bird observations in the area of the Eel River impoundment (including riparian and upland habitats adjacent to the river) have been collected by local birdwatchers since 1969 (Madden, pers. comm.; Lushington, pers. comm.). The species observed and, where available, the season of observation, relative abundance, and other information are presented in Table 3.6.3.

Table 3.6.3 Compilation of Migratory Bird Observations in Area of Eel River Impoundment, 1969 to Present

Species	Season Observed	Relative Abundance[1]	Comments
Pied-billed Grebe	Summer	N/D	Probably breeding in area
Double-crested Cormorant	Summer	N/D	
Common Loon	Summer	N/D	Probably breeding in area
American Bittern	Summer	N/D	Probably breeding in area
Black-crowned Night Heron (*Nycticorax nycticorax*)	Fall	c	
Great Blue Heron	Summer	N/D	
Yellow Rail (*Coturnicops noveboracensis*)	N/O	N/D	Tentatively identified by its call on several occasions
Glossy Ibis (*Plegadis falcinellus*)	Spring	r	
Virginia Rail	Summer	N/D	In very small numbers. Probably breeding in area
Sora	Summer	N/D	Appear to be more common each year. Probably breeding in area
Common Moorhen (*Gallinula chloropus*)	Fall	r	
American Coot (*Fulica Americana*)	Fall/Summer	u	
Spotted Sandpiper	Summer	N/D	Probably breeding in area
Solitary Sandpiper (*Tringa solitaria*)	Spring/Fall	c	
Greater Yellowlegs	Spring/Fall	c	
Lesser Yellowlegs	Fall	u	
Killdeer (*Charadrius vociferous*)	Spring	c	
Common Snipe (*Gallinago gallinago*)	Spring/Fall	c	
American Woodcock (*Scolopax minor*)	N/O	N/A	
Wood Duck	Spring/Fall	c	
Canada Goose	Spring/Fall	c	
American Black Duck	Summer	N/D	Probably breeding in area
Mallard	Summer	N/D	Probably breeding in area
Green-winged Teal	Summer	N/D	
American Widgeon	Summer	N/D	Probably breeding in area
Blue-winged Teal	Summer	N/D	
Ring-necked Duck	Summer	N/D	Probably breeding in area
Northern Pintail (*Anas acuta*)	Spring/Fall	c	
Northern Shoveler (*Anas clypeata*)	Spring/Fall	u	
Greater Scaup (*Aythya marila*)	Fall	u	
Lesser Scaup (*Aythya affinis*)	Fall	c	50-300 at a time
Bufflehead (*Bucephala albeola*)	Fall	u	
Common Goldeneye	Spring/Summer/Fall	c	Probably breeding in area

Table 3.6.3 **Compilation of Migratory Bird Observations in Area of Eel River Impoundment, 1969 to Present**

Species	Season Observed	Relative Abundance[1]	Comments
(*Bucephala clangula*)			
Common Merganser	Summer	N/D	
Red-breasted Merganser (*Mergus serrator*)	N/O	N/A	
Hooded Merganser (*Lophodytes cucullatus*)	Fall	c	Only observed since the 1980s
Bonaparte's Gull (*Larus Philadelphia*)	Fall	c	
Ring-billed Gull (*Larus delawarensis*)	Spring/Fall	c	
Herring Gull (*Larus argentatus*)	Spring/Fall	c	
Great Black-backed Gull (*Larus marinus*)	Spring/Fall	c	
Common Tern (*Sterna hirundo*)	Spring/Fall	c	
Osprey	Summer	N/D	At least 6 active nests within a kilometer of the impoundment and another 6 whose occupants' fish from the impoundment at least occasionally
Barred Owl (*Strix varia*)	N/O	N/A	
Belted Kingfisher	Spring/Fall	c	
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	N/O	N/A	
Downy Woodpecker (*Picoides pubescens*)	N/O	N/A	
Hairy Woodpecker (*Picoides villosus*)	N/O	N/A	
Black-backed Woodpecker (*Picoides arcticus*)	N/O	N/A	
Pileated Woodpecker (*Dryocopus pileatus*)	N/O	N/A	
Olive-sided Flycatcher (*Contopus cooperi*)	N/O	N/A	
Alder Flycatcher (*Empidonax alnorum*)	N/O	N/A	
Eastern Phoebe (*Sayornis phoebe*)	N/O	N/A	
Red-eyed Vireo (*Vireo olivaceus*)	N/O	N/A	
Philadelphia Vireo (*Vireo philadelphicus*)	N/O	N/A	
Blue Jay (*Cyanocitta cristata*)	N/O	N/A	
American Crow	N/O	N/A	
Northern Raven (*Corvus corax*)	N/O	N/A	
Tree Swallow	Summer	N/D	
Bank Swallow	N/O	N/A	
Cliff Swallow (*Petrochelidon pyrrhonota*)	N/O	N/A	Small numbers
Barn Swallow	Summer	N/D	
Black-capped Chickadee (*Poecile atricapilla*)	N/O	N/A	
Boreal Chickadee (*Poecile hudsonica*)	N/O	N/A	
Red-breasted Nuthatch (*Sitta	N/O	N/A	

Table 3.6.3 **Compilation of Migratory Bird Observations in Area of Eel River Impoundment, 1969 to Present**

Species	Season Observed	Relative Abundance[1]	Comments
Canadensis)			
Brown Creeper (*Certhia Americana*)	N/O	N/A	
Winter Wren (*Troglodytes troglodytes*)	N/O	N/A	
Marsh Wren (*Cistothorus palustris*)	Spring/Summer	r	
Ruby-crowned Kinglet (*Regulus calendula*)	N/O	N/A	
Veery (*Catharus fuscescens*)	N/O	N/A	
Hermit Thrush (*Catharus guttatus*)	N/O	N/A	
American Robin (*Turdus migratorius*)	N/O	N/A	
Gray Catbird (*Dumetella carolinensis*)	N/O	N/A	
Nashville Warbler (*Vermivora ruficapilla*)	N/O	N/A	
Northern Parula (*Parula Americana*)	N/O	N/A	
Cape May Warbler (*Dendroica* tigrma)	N/O	N/A	
Magnolia Warbler (*Dendroica magnolia*)	N/O	N/A	
Yellow-rumped Warbler (*Dendroica coronata*)	N/O	N/A	
Black-and-white Warbler (*Mniotilta varia*)	N/O	N/A	
Blackburnian Warbler (*Dendroica fusca*)	N/O	N/A	
Black-throated Green Warbler (*Dendroica virens*)	N/O	N/A	
Blackpoll Warbler (*Dendroica striata*)	N/O	N/A	
Bay-breasted Warbler (*Dendroica castanea*)	N/O	N/A	
Palm Warbler (*Dendroica palmarum*)	N/O	N/A	
Yellow Warbler (*Dendroica petechia*)	N/O	N/A	
Mourning Warbler (*Oporornis Philadelphia*)	N/O	N/A	
Canada Warbler (*Wilsonia Canadensis*)	N/O	N/A	
Ovenbird (*Seiurus aurocapillus*)	N/O	N/A	
Northern Waterthrush	Summer	-	
Common Yellowthroat (*Geothlypis trichas*)	N/O	N/A	
American Redstart (*Setophaga ruticilla*)	N/O	N/A	
Chipping Sparrow (*Spizella passerine*)	N/O	N/A	
Savannah Sparrow	N/O	N/A	
Lincoln's Sparrow (*Melospiza lincolnii*)	N/O	N/A	

Table 3.6.3 Compilation of Migratory Bird Observations in Area of Eel River Impoundment, 1969 to Present

Species	Season Observed	Relative Abundance[1]	Comments
Song Sparrow (*Melospiza melodia*)	N/O	N/A	
Swamp Sparrow	Summer	N/D	
White-throated Sparrow (*Zonotrichia albicollis*)	N/O	N/A	
Dark-eyed Junco (*Junco hyemalis*)	N/O	N/A	
Red-winged Blackbird	Summer	N/D	Probably breeding in area
Common Grackle (*Quiscalus quiscula*)	N/O	N/A	
Rusty Blackbird (*Euphagus carolinus*)	N/O	N/A	

[1] c= common; u= uncommon; r = rare (Madden pers. comm.).
[1] N/D = not determined; N/O = not observed; N/A = not applicable.

Other aquatic bird species that have been recorded annually in waters downstream of the dam (*i.e.*, Eel River estuary and Eel Bay) include (Madden, pers. comm.):

- Red-throated Loon (*Gavia stellata*);
- Horned Grebe (*Podiceps auritus*);
- Red-necked Grebe (*Podiceps grisegena*);
- Snowy Egret (*Egretta thula*);
- Snow Goose (*Chen caerulescens*);
- Common Eider (*Somateria mollissima*);
- Long-tailed Duck (*Clangula hyemalis*);
- Black Scoter (*Melanitta nigra*);
- Surf Scoter (*Melanitta perspicillata*);
- White-winged Scoter (*Melanitta fusca*);
- Barrow's Goldeneye (*Bucephala islandica*; a species of Special Concern); and
- Bald Eagle (*Haliaeetus leucocephalus*).

Based on the 2004 survey and observations by local birdwatchers, a total of 113 bird species have been documented in the Eel River impoundment, the estuary below the dam, and in Eel Bay adjacent to Eel River bar.

Changes in the relative abundance of several species have been noted in the area since the late 1960s (Madden, pers. comm.). For example, the breeding population of Black Ducks appears to have declined on the impoundment. This apparent decrease in Black Duck numbers has also been noted elsewhere in Restigouche County since the late 1970s (Madden, pers. comm.). American Widgeon have appeared to increase in the impoundment since the 1970s, where cattail cover, ideal habitat for American Widgeon, is abundant. Elsewhere in Restigouche County, breeding American Widgeon still seem to be uncommon (Madden, pers. comm.). Casual observations have also indicated that Green- and Blue-winged Teal numbers have declined in the impoundment over the last three decades while remaining stable elsewhere in Restigouche County. This apparent change in Teal numbers at Eel River is possibly due to a change in vegetation in the impoundment area (Madden, pers. comm.).

Both Wood Duck and Northern Shoveler numbers have increased in the impoundment and generally throughout New Brunswick since the early 1970s. Since that time, Wood Ducks have become common. Northern Shovelers are still considered uncommon (Madden, pers. comm.).

Snow Geese were rarely recorded in Restigouche County until five years ago, when approximately 5,000 birds began to use the Restigouche River estuary as a spring staging area. Since that time, Snow Geese have also been observed in the Eel River estuary in spring. The Canada Goose population has increased at Eel River since the province embarked on a re-population program at Richibucto, Grand Lake and Edmundston in the early 1990s. The reared birds appear to have attracted wild migrant Canada Geese, particularly in the fall, since the population of Canada Geese at Eel River and Charlo has increased from only 60 to 70 birds in the early 1970s to several hundred by 2002. Some Canada Geese currently use the Eel River impoundment for overnight roosting (Madden, pers. comm.).

Double-crested Cormorants also appear to have increased in number in the impoundment since the early 1980s. From 1970 until 2000, the breeding colony of Double-crested Cormorants frequenting the impoundment existed only at Heron Island, approximately 8 km away. However, in 2001, Double-crested Cormorants also began to nest on Bon Ami Rocks, only 3 km from the impoundment. In 2003, an estimated 300 to 400 individuals were nesting at this site (Madden, pers. comm.).

The number of Osprey using the impoundment area appears to have increased in recent years, possibly due to the fact that NB Power has built two artificial nesting platforms on the impoundment (in 2001), and there is another Osprey nest on the transmission line towers adjacent to the impoundment (Madden, pers. comm.).

The Eel River impoundment has the largest cattail marsh north of the Tantramar/Midgic Marshes at Sackville. The number of bird species using the impoundment indicates that the area is highly productive. This is further evidenced by the observation of 19 loons simultaneously using the impoundment during the migratory bird survey in June 2004. The impoundment also represents the largest freshwater body in New Brunswick that is adjacent to the Gulf of St. Lawrence and the abundance of migrating and spawning alewives (gaspereau) make it an important foraging area of the Double-crested Cormorant colony at Bon Ami Rocks.

3.6.3 Species of Conservation Concern

There were no bird Species of Conservation Concern identified within the Assessment Area other than the American Wigeon. This species is known to use other areas for breeding in the Town of Dalhousie area very nearby. Species at Risk (*i.e.,* those protected by an Act) are discussed in Section 3.7.

3.6.4 Ecologically Sensitive and Protected Areas

The Eel River impoundment and estuary below the dam is a provincially designated Environmentally Significant Area (ESA #6) for the following reasons:

- the most species of nesting waterfowl known to exist north of Tantramar Marshes;
- the densest population of muskrats known to exist north of Moncton; and
- contains several orchid species (unidentified) and two plant species of special status (*Arabis divaricarpa* and *Ranunculus aquatilis var. calvescens*)

Neither of the above noted plants was found during 2004 field surveys conducted for the Project.

Identified as a Species of Special Concern by New Brunswick, *Arabis divaricarpa* was seen on the rocky shoreline at the mouth of Eel River. This location is outside the impoundment and there is no potential risk for pathway interaction between the Project and this plant species. *Ranunculus aquatilis var. calvescens* is not considered a Species at Risk or a Species of Special Concern by any agency and currently there is no basis to determine that there is any risk factor for this species. *Ranunculus aquatilus* is very common in the Province but the taxonomy is very complex and there are widely variable regional distinctions among its varieties (Hinds, 2000).

3.7 Species at Risk

Species at Risk are considered to be all species listed under Schedule 1 of the Canadian *Species at Risk Act* (*SARA*) and/or species listed under the New Brunswick *Endangered Species Act*. This section summarizes the known occurrences and potential for the presence of Species at Risk that may be affected by the Project.

3.7.1 Aquatic Species

No aquatic Species at Risk have been identified in the Assessment Area (Government of Canada, 2005; NBDNR, 2005).

3.7.2 Vascular Plants

No vascular plant Species at Risk have been identified in the Assessment Area (Government of Canada, 2005; NBDNR, 2005).

3.7.3 Wildlife

No wildlife Species at Risk have been identified in the Assessment Area (Government of Canada, 2005; NBDNR, 2005).

3.7.4 Migratory Birds

Four bird species have been identified as At Risk by the Government of New Brunswick through the New Brunswick *Endangered Species Act* (NBDNR, 2005).

- Bald Eagle (Regionally Endangered);
- Peregrine Falcon (*Falco peregrinus anatum*; Endangered);
- Piping Plover *(Charadrius melodus*; Endangered); and
- Harlequin Duck (*Histrionicus histrionicus*, Endangered).

Under the *Species at Risk Act* (*SARA*) (Government of Canada, 2005):

- Bald Eagle (Not considered at risk);
- Peregrine Falcons (Threatened),
- Piping Plover (Endangered);
- Harlequin Duck (Species of Special Concern);
- Yellow Rail (*Coturnicops noveboracensis*; Species of Special Concern); and
- Barrow's Goldeneye (*Bucephala islandica*; Species of Special Concern).

The Yellow Rail has not been observed in the Assessment Area, however, has been identified by call. The critical breeding habitat for the Yellow Rail is typically marshes (particularly salt), and the drier margins of estuaries. Therefore, it is likely that the Project will have a positive environmental effect on the availability of critical habitat for the Yellow Rail.

Barrow's Goldeneye has been observed in the Eel River estuary (below the dam), and in Eel Bay. This species is known to winter in estuaries and bays in the Maritime provinces. Therefore, it is likely that the Project will have a positive environmental effect on the availability of critical habitat for the Barrow's Goldeneye.

Of these species, only Bald Eagle and Peregrine Falcon have been observed in the general area of Eel River. Bald Eagles have generally been observed in the Eel River area, near the Dalhousie Thermal Plant and Bon Ami Rocks, primarily during fall and winter. Eagles probably use this area because of the presence of waterfowl, and there are scavenging opportunities on fish discarded by ice fishers (Letourneau, pers. comm.). Bald Eagle sightings between the estuary below the dam and the Town of Dalhousie have increased between the early 1970s and the mid-1980s. Sightings of Bald Eagles during the early 1970s were rare; however, sightings of one or more Bald Eagles are now not uncommon in this area (Madden, pers. comm.). A Bald Eagle was recorded during the fall survey in 2005 on the south shore of the impoundment (Table 3.6.2). Eagles may occasionally visit the Assessment Area, but it is not considered critical habitat for the species.

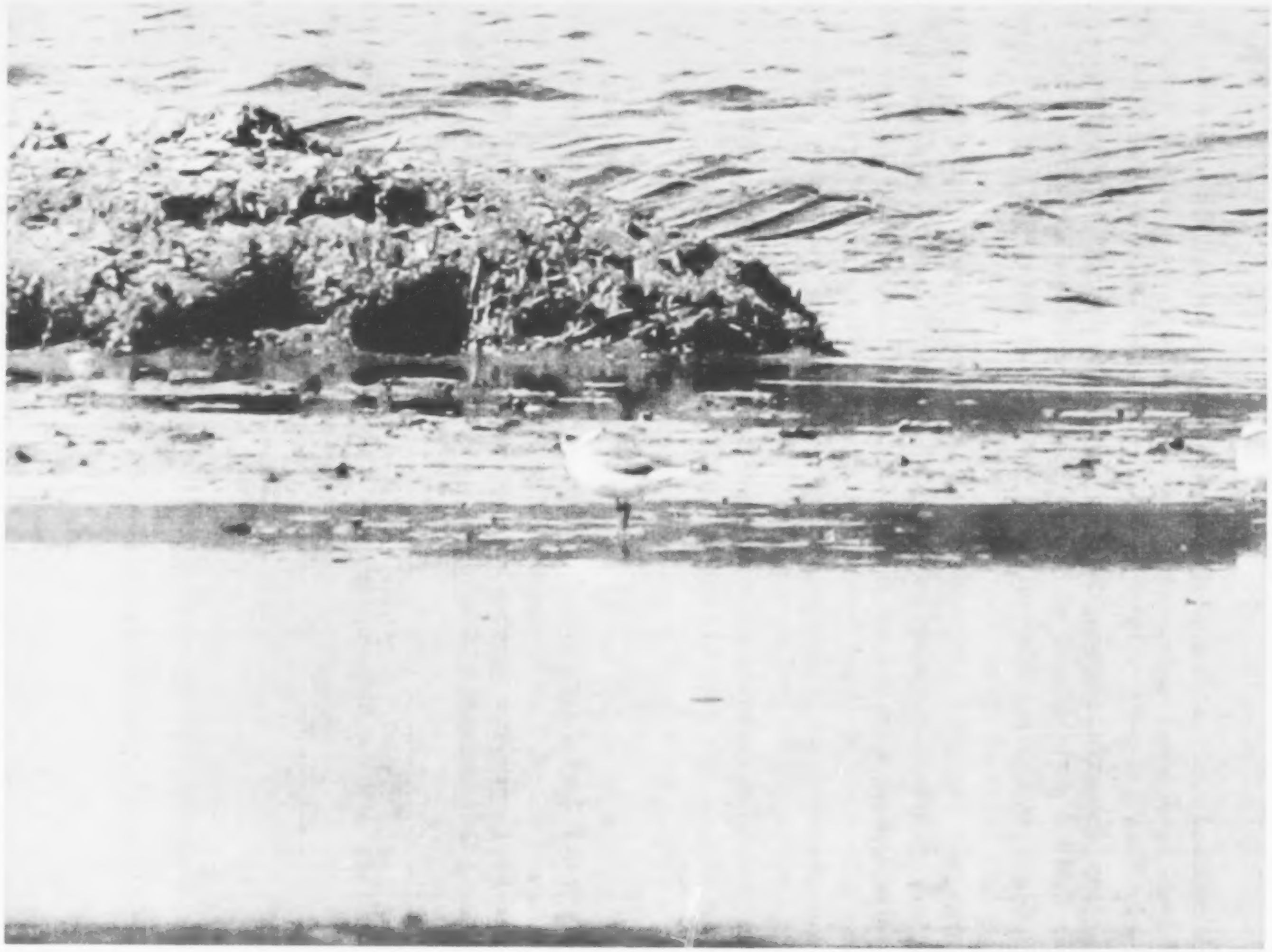


Photo of Semipalmated Plover Observed on the Exposed Bottom of the Impoundment in August 2005	Date: 03/31/2006	Scale:	**Eel River Dam** - ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **3.7.1**	NBDSS PROJECT No. YR101A

Peregrine Falcons have been observed in the same general area of Eel River, also in the fall, presumably because of the concentration of waterfowl, a favoured prey of Peregrines. The area around the Thermal Plant and the Bon Ami Rocks also offers perch sites on cliffs and rocks that are not available in the Eel River impoundment area. There is currently no reasonable risk for pathway interaction between the Project and the Peregrine Falcon.

The Eel River area does not currently provide potential habitat (*i.e.*, sandy beaches) for Piping Plover. However, during a period of exposed mudflats in the impoundment when water levels were very low in August 2005, Semipalmated Plovers were observed (Figure 3.7.1) and which have similar habitat preferences as that of Piping Plovers. There were two separate observations of Piping Plover in the sandy portion of the estuary below the dam, and on the seaside of the Eel River bar, respectively, during the migratory bird survey in September 2005. However, it is not anticipated that the Project will result in substantial increases to the availability of critical habitat for Piping Plover. Therefore, the environmental effects of the Project on the Piping Plover are anticipated to be neutral. While it is possible that Harlequin Ducks may use the Eel River estuary or nearby Eel Bay for foraging, no observations of Harlequin Duck have been made in the Eel River area (Madden, pers. comm). However, in the last decade, Harlequin Ducks with offspring have been observed annually in the Charlo River estuary. Adult pairs have been observed at least once in the Charlo estuary (Hodgson, pers. comm.) and once on the South Charlo River (Ross, pers. comm.). Harlequin Ducks also likely nest on nearby Benjamen River since a brood was observed in the estuary of that river in 1999 (Lushington, pers. comm.). Harlequin Ducks favour fast flowing rapids for breeding. No such habitat exists in the vicinity of the Project.

Other species listed under *SARA* such as Eskimo Curlew (*Numenius borealis*; Endangered) and Roseate Tern (*Sterna dougallii*; Endangered) are not likely to occur in the Eel River area. The nearest nesting colony of Roseate Terns is on the Magdalen Islands in the Gulf of St. Lawrence, approximately 250 km away. The population of Eskimo Curlews is currently unknown but is considered extremely small (Government of Canada, 2005) and it is very unlikely that this species would occur in the Eel River area.

The Eel River impoundment does not appear to provide important habitat for any bird Species at Risk identified by the New Brunswick *Endangered Species Act* or by *SARA*.

3.8 Water Resources

Consideration of the Water Resources VEC in the Assessment Area comprises Groundwater, Surface Water and Water Resources Infrastructure.

3.8.1 Groundwater

Consideration of Groundwater includes the several elements, including surficial geology, bedrock geology, hydrogeology, groundwater use, and groundwater availability.

3.8.1.1 Surficial Geology

3.8.1.1.1 Pre-dam Conditions

The area surrounding Eel River dam is part of three physiographic regions including Chaleur Coastal Plain, Campbellton Hills and Jacquet Plateau.

Regional mapping indicates the surficial geology in the lower reaches of the Eel River watershed, including those areas adjacent to the impoundment, consists of marine sediments from the late Wisconsinan (70,000-10,000 years BP) and/or early Holocene (10,000 years BP to present) eras (Rampton *et al.*, 1984). These sediments consist of sand, sediment, with some gravel and clay that were deposited in shallow marine water conditions and are generally in blankets 0.5 to 1.5 m thick (Rampton *et. al.*, 1984). There may be patches of clay and sediment present at the ground surface in broad, flat areas. Clay and sediment are interbedded in the sand and gravel in low coastal areas and are also commonly present in valleys or depressions. The long-term risk of water erosion on bare, unprotected soil is low to high. Soils are generally well drained and have slightly acid pH except where calcium-rich groundwater seeps out at the surface and in areas where soils have been deeply disturbed by tilling. Soils consisting of stiff clayey sediments and dense reddish brown sand and gravel with some sediment have been found in the area of the dam. Boulders and cobbles were also found in the area with the quantity increasing with depth.

The surficial geology of the middle and upper reaches of the watershed include exposed pre-Quaternary (before 1.8 million years before the present) bedrock and glacially deposited sediments in the Chaleur Coastal Plain, Campbellton Hills and Jacquet Plateau. These glacially deposited sediments consist of lodgement till (sediment deposited by plastering of glacial debris from a sliding glacier bed), ablation till (glacial material left by a melting glacier), and associated sand and gravel deposited directly by Late Wisconsinan (70,000 to 10,000 years before present) ice or with minor re-working by water (Rampton *et al.*, 1984). Although aggregate deposits are generally uncommon in this area (NBDOE, 1979), deposits of sand and gravel left over from glacial melt water streams are located in the Dundee and Balmoral areas (TAP, 2003).

3.8.1.1.2 Post-dam and Existing Conditions

Surficial geology is a long-term condition and as such is not expected to have discernibly changed over the relatively short time frames since the emplacement of the dam.

3.8.1.2 Bedrock Geology

3.8.1.2.1 Pre-dam Conditions

The bedrock (solid rock, either exposed at surface or underlying surficial deposits) around the dam is Pennsylvanian (325 to 286 million years Before the Present (BP)) or younger in age and consists of red to grey sandstone, conglomerate (cemented material; rock consisting of rounded and waterworn gravel imbedded in a finer material) and siltstone (Geological Survey of Canada, no date; NBDNR, 1979). The sandstone bedrock in the area is typically described as weak to medium-strong rock while the mudstones are described as extremely weak. Bedrock is typically encountered within 6 m of ground surface and some rock outcroppings can be expected.

The predominant structural trend in the Assessment Area is southwest to northeast. Major faults in the area follow this trend and have a major influence on surface water drainage patterns and groundwater flow direction (NBDOE, 1979).

Bedrock in the lower reaches of the Eel River watershed, including those areas immediately adjacent to the impoundment, are the calcium-rich red to grey sandstones and conglomerates with interbedded siltstone and shale of the Bonaventure Formation (Davies, 1977). The upper reaches are primarily underlain by Silurian-aged calcareous sandstone and siltstone of the Chaleur Group, although portions of the northern edge of the watershed may be underlain by the lower Devonian aged volcanic rocks and mudstone and sandstone of the Dalhousie Group (Davies, 1977).

3.8.1.2.2 Post-dam and Existing Conditions

Bedrock geology is a long-term condition and as such is not expected to have discernibly changed over the relatively short time frames between the pre-dam and existing conditions.

3.8.1.3 Hydrogeology

3.8.1.3.1 Pre-dam Conditions

Although no specific information regarding hydrogeology (the distribution and movement of groundwater in the soil and rocks of the Earth's crust) in the Assessment Area prior to construction of the Eel River dam is available, hydrogeology is a long-term condition and as such is not expected to have discernibly changed over the relatively short time frames defined as pre-dam and existing conditions. The potential exception is with respect to saltwater intrusion. In theory, prior to the impoundment of freshwater above the dam, there would have been greater potential for saltwater intrusion within the tidal estuary zone. However, specific documentation of this occurring is not available.

The marine glacial deposit sediments that constitute the majority of the surficial geology within the Assessment Area are of limited thickness and are not expected to provide sufficient groundwater for development purposes. The mapped deposits from glacial melt water streams may provide significant quantities of groundwater; however, the deposit in the Dundee area is currently being mined and the deposit in the Balmoral area is currently being exploited as the municipal water supply.

The hydrogeologic units underlying the majority of the Assessment Area consist of bedrock in which the groundwater impoundment is relatively small. Although some bedrock wells may have yields as high as 2 L/s), most produce less than 0.5 L/s (NBDOE, 1979).

The primary porosity (the existence of pores or holes in soil or rock, and the ratio of the volume of all these pores to the volume of the whole) of both the Chaleur and Dalhousie Groups is low, and groundwater is confined to fractures and faulting within the rock. Hence, development of significant yields would likely be limited to those areas of intersecting fracture systems. Similarly, the primary porosity of the Bonaventure Formation is expected to be limited by secondary calcite mineralization and hence potential well yields within the formation would also be dependent on the well location with respect to major fracture systems.

The groundwater quality within the Assessment Area is generally considered to be fairly good; however, the water tends to be hard (TAP, 2003) and saltwater intrusion is known to occur in the coastal areas (NBDOE, 1979).

3.8.1.3.2 Post-dam and Existing Conditions

Hydrogeology is a long-term condition and as such is not expected to have discernibly changed over the relatively short time frames between the pre-dam and existing conditions.

3.8.1.4 Groundwater Use

3.8.1.4.1 Pre-dam Conditions

There are currently no data regarding groundwater use prior to dam construction in 1963.

3.8.1.4.2 Post-dam and Existing Conditions

Municipal groundwater use within the Assessment Area occurs in the Village of Balmoral. The village's water supply is obtained from three production wells that were completed in sand and gravel deposits. The well yields range from 5.6 to 16 L/s (TAP, 2003). A wellfield protection study has been completed for the Balmoral wellfield, although the wellfield has not yet been designated under the *Wellfield Protected Area Designation Order - Clean Water Act*.

The residents of Village of Eel River Crossing (ERC) are all connected on the municipal water supply system (Bujold, pers. comm.). This system is based on the supply of surface water from the nearby watershed where the intake is located in Eel River above ERC, and not based on groundwater supply. There is no knowledge of any residents in this area using groundwater wells (Bujold, pers. comm.). The water supply and sewerage systems of the Eel River Bar First Nation are connected to the Town of Dalhousie.

The majority of the Eel River watershed is located in a rural area. Domestic water supplies outside of Eel River, Eel River Crossing, and Balmoral are provided by individual wells. A previous study (TAP, 2003) reviewed the NBENV Well Driller's Reports for water wells drilled within the area. The findings indicated that the majority of wells (104 of 114) were drilled in bedrock to an average depth of 44 m, and had an average yield of 0.97 L/s, although there was a wide range of well yield reports, with some wells having no yield.

3.8.1.5 Groundwater Availability

3.8.1.5.1 Pre-dam Conditions

There are currently no data regarding groundwater use prior to dam construction in 1963.

3.8.1.5.2 Post-dam and Existing Conditions

As noted in Section 3.8.1.4.2, the range of well yields based on Well Driller's Reports is quite wide, and likely reflects the randomness of the well locations with respect to water-bearing fracture zones. In general, sufficient well yields for individual residential developments are likely present within most of the Assessment Area.

A previous study (TAP, 2003) reviewed the available information for the purposes of identifying exploration targets for larger wellfield developments. The study identified four potential targets within the Assessment Area:

- a sand and gravel aquifer to the east of the Village of Balmoral;
- a bedrock aquifer to the south of the Village of Eel River Crossing;
- a bedrock aquifer to the south of the Village of Charlo; and
- a bedrock aquifer to the north of the Village of Balmoral.

The estimated yield of the sand and gravel aquifer is over 15 L/s, while the estimated yields of the bedrock aquifers range from 3.8 to 11 L/s. To date, none of these targets have been developed.

3.8.2 Surface Water

Surface Water includes consideration of both surface water use and surface water availability.

3.8.2.1 Surface Water Use

3.8.2.1.1 Pre-dam Conditions

Prior to the construction of the Eel River dam, no surface water use was associated with the Eel River at the current location of the impoundment. The first municipal water system for the Town of Dalhousie was installed in 1908. It consisted of cast iron watermains and a constructed dam along McNeish

Brook, beyond the west end town limits of Dalhousie (BMA, 2001). The Charlo River dam was built in 1929, providing a new municipal water supply for the Town of Dalhousie (including the ERBFN). First owned and operated by the New Brunswick International Paper Company (NBIP), the Charlo River dam water system supplied 62,500 m^3/day of water to the NBIP paper mill and the Town of Dalhousie municipal water system (BMA, 1996 and 2001).

3.8.2.1.2 Post-dam and Existing Conditions

In 1963, the Eel River dam was constructed and the Eel River tidal estuary was converted into a freshwater impoundment to provide an additional source of potable water, in response to increased water demand by the Town of Dalhousie (including the ERBFN) and to accommodate a new chemical plant, Canadian Industries Ltd (CIL) (BMA, 1996 and 2001). Also, the existing Charlo River dam water system had proven to be inadequate during extended dry periods. The Eel River pumping station was built and water was pumped from the Eel River impoundment into the Charlo River dam water system, increasing the water supply to the paper mill and the Town of Dalhousie to 66,800 m^3/day (BMA, 1996). The new water supply system was originally owned by the Town of Dalhousie (BMA, 2001).

The water quality in the Eel River impoundment proved to be poor compared to that of the Charlo River, and numerous complaints were received from Dalhousie residents (BMA, 1996). In 1969, a new pumping station and separate watermain to the paper mill was constructed to accommodate increased water demand by the mill, the proposed NB Power thermal generating station in Dalhousie, and in response to the complaints from residents. The pumping station and separate watermain was renamed the Dalhousie Industrial Water System (DIWS).

Ownership of the Eel River water supply was transferred from the Town of Dalhousie to the New Brunswick Water Authority (NBWA), a Provincial agency. Through a reciprocal agreement, the NBWA coordinated the use of the water supply, while the Town of Dalhousie continued to operate and maintain it (BMA, 2001). The Town of Dalhousie (including the ERBFN) reverted to using only the higher quality water provided by the Charlo River dam water system, leaving the paper mill and NB Power generating station as the only remaining users of the DIWS (*i.e.*, the water from the Eel River impoundment). Notably, the Village of Eel River Crossing developed an infiltration gallery system in 1976 on the Eel River near Shannonvale (upstream of the impoundment) for access to potable water, and continues to use this water supply today (TAP, 2003).

The NBWA had contracts with all of the aforementioned DIWS users. The contracts stipulated that users were fully responsible for the cost of operating and maintaining the DIWS. There was no expiry date on the contracts. Users could terminate the contracts on three months notice, but the NBWA had no similar exit clause.

In the 1970s, four fire hydrants were connected to the DIWS on William Street between the Dalhousie fire station and paper mill for fire protection for the area around the ice arena and nearby houses (BMA, 1996). The watermain of the DIWS had a larger diameter and higher flow than that of the Charlo River dam water system, making it more appropriate for the fire hydrants. At the time, the watermain used by the Town of Dalhousie (*i.e.*, the Charlo River dam pipeline) was smaller in diameter and the water pressure would have been insufficient for use for the fire hydrants (NB Power, 2005).

In the late 1970s, a connection was made to the DIWS watermain to provide adequate fire protection to a new storage shed constructed on the East Wharf, owned by Transport Canada. There was no consumptive use of this water supply; therefore, the user simply paid a fixed rate for having the standby service available (BMA, 1996). Similarly, another connection was made to the DIWS watermain in 1991, to provide adequate fire protection to the former St. Joseph Hospital (now the Dalhousie Community Health Centre) on Victoria Street in Dalhousie.

In 1992, the ERBFN negotiated a new compensation agreement with the Province of New Brunswick for the loss of water resources (*e.g.*, clam digging, smelt fishery) as a result of the construction of the Eel River dam and subsequent redirecting of the Eel River. A previous agreement that was negotiated in 1970 (a 20-year contract that expired in 1990) provided a relatively modest financial compensation of $15,000 to the ERBFN for the loss of aquatic resources in the Eel River estuary. Through the new compensation agreement, the ERBFN obtained $204,000 per year for five years, effective July 31, 1995 (ACOA, 2003). The agreement also included back pay to 1990, to cover the years following the expiration of the original contract during which negotiations took place for the new agreement. As always, the responsibility for the payment of this financial compensation was borne by the users of the DIWS, as stipulated in the original contracts with the NBWA.

In 1994, NBIP was renamed Avenor Maritimes Inc., which was subsequently acquired by Bowater Maritimes Inc. in 1998 (Bowater, 2005; Clancy and Sandberg, no date). In addition to the paper mill, Bowater gained ownership of the Charlo River dam (BMA, 2001). Also in the mid-1990s, the NBWA authority for the DIWS, including all user contracts, was transferred to NBENV (formerly NBDOE) (BMA, 2001; LeBlanc, pers. comm.).

Over the years, the paper mill had slowly reduced its dependence on the DIWS due to the poor quality of the Eel River impoundment water, which contains high Total Suspended Sediments (TSS). Bowater had installed inclined screen filters to remove the suspended sediments from the impoundment water, but a sticky, slimy sludge that plugged the filters still remained (Bowater, 2004). By the late 1990s, the paper mill was using the Charlo River dam water supply for all of its operations, except for fire protection and backup water supply during dry periods (BMA, 1996 and 1998).

Bowater recently terminated its agreement with NBENV, no longer having a need for water from the DIWS for fire protection and backup water supply following the completion of upgrades to both the paper mill and Charlo River dam water supply system (Bowater, 2004). Since Bowater is at the terminal end of the DIWS, and at the request of the Town of Dalhousie (*i.e.*, operator of the DIWS), Bowater has agreed to maintain the water flow through the mill during the winter at a rate required to prevent the pressurized watermain from freezing (this pipeline froze in 1984 and 2003). Bowater would like to eliminate the need to maintain the watermain in this manner (Bowater, 2004).

The Town of Dalhousie also recently terminated its agreement with NBENV (although it will continue to operate and maintain the DIWS on behalf of NBENV), leaving NB Power as the only user of the DIWS. As was the case for Bowater, NB Power has found the quality of the water from the Eel River to be inadequate as an industrial water supply. Problems with water contaminants have occurred for the past 3 to 4 years, which include elevated conductivity levels and TSS, caused in part by repairs and maintenance needed for the Eel River dam (NB Power, 2005).

High conductivity levels are the result of high chloride concentrations in the water due to occasional saltwater intrusion through the stop logs, fishway and weir. During the low water level event in the impoundment in July and August 2005, the conductivity of the water in the impoundment was as high as 1200 µS/cm (Figure 3.4.10). The high conductivity of the water makes it unsuitable for use in the boilers of the generating station. A portion of the water (roughly 10 to 15 percent of the total water consumption) is demineralized through reverse osmosis (RO) treatment, so that it can be used in the boilers. Treatment is not required for the use of raw water in other parts of the generating station (Bielecki, pers. comm.). However, the higher the TSS in the untreated water, the harder it is on the equipment and piping.

The generating station has two reverse osmosis units, the most recent of which was purchased in March 2005. Each reverse osmosis unit is capable of treating approximately 0.37 m^3/min. of water, but normally only one unit is in service at a time (Bielecki, pers. comm.). The reverse osmosis units can handle short-term exceedences of their conductivity design value of 566 µS/cm. However, this is not desirable as it affects the lifespan of the reverse osmosis units and means that a higher level of treatment will be required downstream in the process to achieve the desired water quality for use in the boilers. In general, the higher the conductivity and TSS of the raw water supply, the higher the demand placed on the water treatment plant (Bielecki, pers. comm.).

The four fire hydrants on William Street remain connected the DIWS for fire protection. However, four additional fire hydrants that are connected to the Town of Dalhousie municipal water system were installed recently on William Street, adjacent to the original hydrants that were installed in the 1970s. The municipal water system is capable of supplying sufficient flow and water pressure for the hydrants following upgrades to the system that involved the replacement of the watermain with one that is a larger in diameter (Guitard, pers. comm.). The impending decommissioning of the DIWS and the four old fire hydrants will not affect fire protection for the area, as the newer hydrants are considered to be capable of providing adequate fire protection alone.

The agreement between NBENV and Transport Canada for the use of water from the DIWS for fire protection for the East Wharf storage shed expired on June 30, 2005. NBENV did not renew this agreement (LeBlanc, pers. comm.). Bowater was the main beneficiary of fire protection on the wharf, but is now capable of providing its own fire protection because Public Works connected a pipeline from Bowater's Charlo River water supply watermain to the storage shed for fire protection for the wharf on January 20, 2006 (Robichaud, pers. comm.). There is apparently not a written contract for the agreement regarding the water supply for fire protection to the former St. Joseph's Hospital. NBENV is currently in discussions with the the Dalhousie office of the Department of Health and Wellness (DHW) regarding an alternate water supply to ensure that fire protection continues to be available for the Dalhousie CHC (LeBlanc, pers. comm.).

The five-year compensation agreement between NBENV and the ERBFN, signed in 1995, was extended until renewal of the present contract in 2001. The present contract is set to expire in the summer of 2006. As part of the agreement, NBENV committed to the ERBFN that the Eel River dam would be removed (this commitment occurred prior to any discussion regarding whether an EIA would be required). The termination of contracts and agreements between NBENV and Bowater, the Town of Dalhousie, and Transport Canada currently leaves NB Power solely responsible for all costs associated with operating and maintaining the DIWS until the removal of the Eel River dam, including financial compensation to the ERBFN.

The DIWS infrastructure is failing and substantial upgrades to the piping and spillway structure are required (LeBlanc, pers. comm.). If the Eel River dam were not removed and the use of the DIWS were to continue beyond 2006, NB Power would be facing considerable cost for these system upgrades. NB Power is currently undertaking an economic analysis of alternate water supply sources for its generating station (refer to Section 3.8.2.2). Although replacing the water supply will require additional expenditure, NB Power would bear significant capital and operating costs with the continued use of the DIWS beyond 2006, namely with respect to the system upgrades and the financial compensation to the ERBFN. For this reason, along with the poor water quality of the Eel River and the contractual agreement between NBENV and the ERBFN for the removal of the dam, NB Power must find an alternate source of water supply, regardless of the associated cost and whether the dam is or is not decommissioned.

3.8.2.2 Surface Water Availability

3.8.2.2.1 Pre-dam Conditions

Prior to the construction of the Eel River dam, there was no freshwater supply downstream of the Village of Eel River Crossing. This portion of the Eel River was subject to tidal flushing twice daily and therefore was comprised of a mixture of freshwater and saltwater. No water was withdrawn from the Eel River estuary at the location of the current impoundment.

Beginning in 1908, the Town of Dalhousie obtained its municipal water supply from McNeish Brook, beyond the west end town limits of Dalhousie (BMA, 2001). With the construction of the Charlo River dam in 1929, the Charlo River dam water system supplied an estimated 59,500 m^3/day of water to the NBIP paper mill and the Town of Dalhousie (NBDOE, 1979). By 1964, the Charlo River dam water system was supplying 62,500 m^3/day of water, but was inadequate during extended periods of dry weather (BMA, 1996).

3.8.2.2.2 Post-dam and Existing Conditions

Various estimates have been made of the non-potable water yield from the existing Eel River impoundment, as there are no hydrometric data for the Eel River. Estimates of annual average daily flow range from 34,100 to 40,900 m^3/day when pro-rated against the Charlo River, and 59,100 to 59,800 m^3/day when compared to the Tetagouche River (NBDOE, 1979). The water quality of the Charlo River is considered to be good, with no discernable odour or colour, and satisfactory turbidity (NBDOE, 1979). The water quality of the Eel River impoundment is not considered to be as good as that of the Charlo River impoundment, for industrial or municipal use, due to factors such as high turbidity and salinity (BMA, 1996).

The only users (former and current) of the DIWS with outstanding issues regarding finding an alternate source of water supply are the Dalhousie Community Health Centre for fire protection and the NB Power generating station. Therefore, the discussion of the post-dam and existing conditions for surface water availability will be limited to these two users.

Dalhousie Community Health Centre

The former St. Joseph Hospital, now the Dalhousie CHC, was originally connected to the DIWS watermain in 1991 to provide a water supply for fire protection (BMA, 1996). With the impending decommissioning of the DIWS, efforts are now underway to secure an alternate water supply for fire protection for the Dalhousie CHC. There is not enough water flow/pressure from the municipal watermain of the Town of Dalhousie at the front of the building on Victoria Street. Further, Bowater Maritimes Inc. will not allow the Dalhousie CHC to tap into its Charlo River water supply watermain, as it does not have the capacity to supply additional users at this time and is concerned about liability issues (Tardif, pers. comm.).

The Dalhousie office of the DHW is currently investigating the possibility of adding a water impoundment for fire protection at the Dalhousie CHC (Tardif, pers. comm.). The former coal storage bunker room at the boiler plant building may be converted for this purpose. This old coal bunker is approximately 9 m long x 10 m wide x 4 m high concrete walls. Appropriate liners could be installed, and the floor above the bunker has sufficient space to house a new fire pump and all of its ancillary valves, piping and control mechanisms. If the volume of this bunker area is determined to be insufficient to meet all of the sprinkler and standpipe hose demand required by the National Fire Protection Association (NFPA)-13 latest revision, the impoundment could be supplied from the nearby city water main along Victoria Street. It appears that the useable impoundment has sufficient volume to supply a 1.9 m^3/min pump for approximately 3.5 hours, which is far more than what NFPA-13 requires for this facility.

NB Power Thermal Generating Station

The NB Power generating station in Dalhousie has been connected to the DIWS since its inception in 1969, following the expansion of the original Eel River pumping station (BMA, 1996). In fact, the Eel River Pumping Station was expanded in part to accommodate the water supply needs of the then-proposed thermal generating station (Bielecki, pers. comm.). Again, with the impending decommissioning of the DIWS, efforts are underway to secure an alternate water supply for the operation of the generating station.

Ideally, the NB Power generating station could be connected to the Charlo River water supply watermain, which passes near the generating station (BMA, 1996). However, Bowater does not have the capacity to supply the water requirements of additional users at this time. In the event that the paper mill closes, this water could be made available pending an agreement between NB Power and the owners. Several alternatives for water supply have been evaluated previously for the Dalhousie area, but only those that meet the needs of the NB Power generating station (average daily consumption of approximately 3,800 m^3/day) will be discussed (Bielecki, pers. comm.).

One alternate water supply under consideration involves the expansion of the Charlo River dam, which entails constructing a storage dam downstream of the confluence of the Charlo River and the North branch of the Charlo River, at an estimated cost of $4,900,000 in 1986 (NGL and PDL, 1986). This option was assessed in the 1980s, but the expansion did not proceed as it was believed to be too expensive and unnecessary at the time (NB Power, 2005). Now however, the increased water supply capacity as a result of such an expansion could enable Bowater to secure water supply during dry periods and supply the water requirements of additional users, including perhaps the NB Power generating station.

The use of sewage effluent from the Town of Dalhousie and Village of Eel River Crossing from the wastewater treatment facility in Dalhousie has been evaluated as a potential industrial water supply for the generating station (NB Power, 2005). However, a large volume of sewage effluent would have to be chlorinated and would require RO and membrane technology treatment because of the chlorides, organics, and suspended solids in the effluent. This treatment process would be very expensive, and would produce demineralized water. The pipes to the power plant boiler and boiler itself could accommodate demineralized water because they are comprised of stainless steel material, as is the scrubber. However, the carbon steel plant water piping systems delivering water to the scrubber building, and the backup cooling, domestic water, and fire protection systems would not be able to withstand corrosion caused by demineralized water. Eventually, these pipes would leach and weaken, and require replacement.

The desalination of seawater from Eel Bay for use as a water supply for the NB Power generating station would pose similar challenges in terms of cost, and the need to address demineralized water resulting from the RO process (NB Power, 2005). To resolve the demineralized water issue, the pipes associated with the scrubber building, and the backup cooling, domestic water, and fire protection systems would have to be changed as for the sewage effluent alternative, and is therefore cost-prohibitive.

The possibility of using Bowater wastewater effluent for the industrial water supply for the generating station has also been considered (NB Power, 2005). However, the effluent would require coagulation, an ultra filtration unit, and membrane technology treatment. Further, the high temperature of the water and inconsistent quality of the effluent would be problematic. Lastly, the water supply for NB Power would be entirely dependent on the paper mill, therefore, a regular supply of effluent could not be guaranteed (*e.g.*, if the mill ceases operation).

The construction of a dam on Black Brook, which converges with the Eel River on the North side of the impoundment, just west of Highway 11, has been suggested as a possible option for alternate water supply for the generating station (NB Power, 2005). Further information on the water elevation head of Black Brook is needed before an evaluation can be made. The creation of a storage impoundment on the upper reaches of Eel River and an upgraded pumphouse at the Village of Eel River Crossing was evaluated previously for the Town of Dalhousie (NGL and PDL, 1986). This alternative would yield approximately 12,000 m^3/day of water at cost of $6,300,000 and annual operating costs of $200,000 (quoted in 1986).

Pumping water from Popelogan Lake, located southwest of the head of the Charlo River, into the Charlo River impoundment has been tried. However, the water level in the lake was lowered too much and the volume of water pumped would not have been enough to meet the operating requirements of the generating station. Other studies report that pumping from the lake in the past has been found to be unacceptable due to interference with riparian rights and for environmental reasons (NGL and PDL, 1986).

The possibility of wellfield development between the Charlo Airport and the community of Mountain Brook has been evaluated previously as a potential alternate water supply for the generating station (NGL and PDL, 1986). The proposed alternate source could consist of two supply wells including submersible pumps, standby diesel generator, 4,540 m^3 water impoundment, and 10 km of 350 mm diameter transmission line (NGL and PDL, 1986; BMA, 1998; NGL and Gemtec Ltd., 1999). The estimated construction cost in 1986 was $4,000,000 to $4,900,000, and the expected annual operating costs was approximately $250,000 (NGL and PDL, 1986).

The development of a 4,500 m^3/day wellfield between the community of Mountain Brook and the Charlo impoundment has also been suggested previously (NGL and Gemtec Ltd., 1999). Further information is needed before an evaluation can be made with respect to cost and suitability of this potential water supply for the generating station. One drawback to wellfield development in both this location and near the Charlo Airport is that domestic wells located on the Mountain Brook Road would be vulnerable to interference drawdowns.

In summary, it would appear that there are a number of technically feasible options for NB Power with respect to alternate water supply. All are costly and further analysis is needed to evaluate their economic feasibility.

3.8.3 Water Resources Infrastructure

Water Resources Infrastructure includes consideration of both industrial and municipal water supply, and wastewater treatment infrastructure.

3.8.3.1 Industrial and Municipal Water Supply Infrastructure

Industrial and municipal water users rely on water supply infrastructure to provide freshwater, typically from groundwater or surface water resources, for their use.

3.8.3.1.1 Pre-dam Conditions

The Charlo River dam was constructed in 1929 to create a water impoundment to supply New Brunswick International Paper (now Bowater Maritimes Inc.) pulp mill in Dalhousie. A 14 km long, 810 mm diameter wood stave pipeline was constructed from the Charlo River, and across Eel River, to serve the pulp mill and the Town of Dalhousie. The Village of Charlo, ERBFN Community, Village of Eel River Crossing, Village of Balmoral, and surrounding rural areas, did not have municipal water systems in place prior to construction of the Eel River dam in 1963. Water was supplied from private wells.

3.8.3.1.2 Post-dam and Existing Conditions

The Charlo River dam and 810 mm diameter pipeline (now upgraded to consist of wood stave, concrete, polyethylene, and cast iron materials) remains in operation under the control of Bowater. The location of the Bowater pipeline is shown in Figure 3.8.1, on the impoundment side of the Eel River dam. A portion of the 810 mm diameter watermain is buried beneath the Eel River, crossing below (east of) the current Highway 11 bridge and attaining the North side of the Eel River at the site of the current pumping station, en route to the paper mill and Dalhousie. This is the only infrastructure currently under the cover of the impoundment.

From 1964 to 1969, the Eel River dam and impoundment provided supplementary water to the existing Bowater pipeline. A new pumping station and separate 900 mm diameter watermain, the DIWS, were constructed in 1969 to supply water directly to the NB Power thermal generating station from the impoundment. A smaller water line connects this main line with the the former Saint-Joseph's Hospital for fire protection. The DIWS infrastructure (*e.g.*, the watermain) is currently failing and substantial upgrades to the piping and spillway structure will be required within a few years (LeBlanc, pers. comm.). In the summer of 2005, stop logs failed at the Eel River dam causing a large portion of the stored water in the impoundment to be released, and impoundment water levels to be substantially drawn down as seen in Figure 3.2.3.

Municipal water services are now provided by all of the formal communities within the Assessment Area. The Town of Dalhousie has a potable water system that has been in place since construction of the Charlo River dam and impoundment in the late 1920s. The ERBFN has had a municipal water supply system, via a 150 mm diameter watermain from the Town of Dalhousie, since the mid-1980s. This system replaced residential and commercial wells.

The Village of Charlo has a drilled groundwater well and piped services that were constructed in 1975 to replace residential and commercial wells. A 300 mm diameter watermain from the well feeds local distribution lines.

The Village of Eel River Crossing has a surface water infiltration system and pumping station that was constructed on the Eel River west of the Village in the Shannonvale area of Dalhousie Parish in 1975. The location of the infiltration system and pumping station is 3 km above the upstream extent of the impoundment and the potential influence of the tide, should the dam be removed. A 300 mm diameter watermain extends to the Village for local supply and distribution to replace residential and commercial wells.

The Village of Balmoral constructed a groundwater well supply, pumping station, and 200-mm diameter watermain in 1978. This system replaced existing residential and commercial wells.

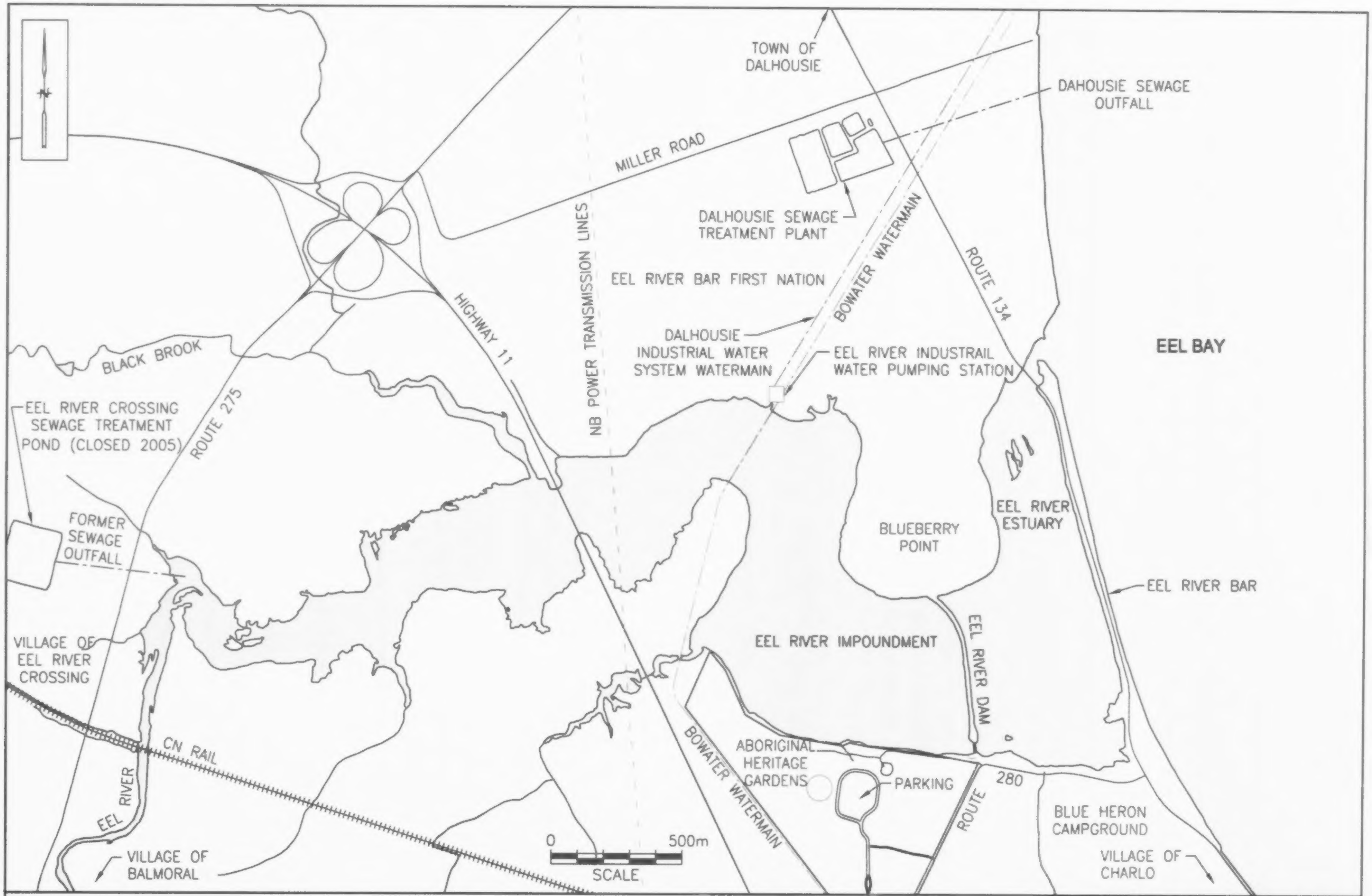
3.8.3.2 Wastewater Treatment Infrastructure

Wastewater treatment facilities do not require freshwater to operate, however, they do often use surface water bodies as locations of discharge for the purpose of further diluting the wastewater effluent, and for transporting the effluent away from the community. There are a number of wastewater treatment facilities within the Assessment Area, both historically and presently, that discharge into surface waters. These are described in the following sections.

3.8.3.2.1 Pre-dam Conditions

There were no wastewater treatment systems in place in the pre-dam period in any of the communities of the Assessment Area. The Town of Dalhousie had some municipal sewage collection, which was disposed into Eel Bay untreated. Otherwise, private systems were used throughout the Assessment Area prior to 1963.

FILE: 15830\EIA REPORT\INFRASTRUCTURE


TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
BOWATER WATERMAIN
ROUTE 134
HIGHWAY 11
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
EEL BAY
BLACK BROOK
ROUTE 275
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
FORMER SEWAGE OUTFALL
BLUEBERRY POINT
EEL RIVER ESTUARY
EEL RIVER BAR
VILLAGE OF EEL RIVER CROSSING
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
CN RAIL
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
BLUE HERON CAMPGROUND
EEL RIVER
VILLAGE OF BALMORAL
0
500m
SCALE
VILLAGE OF CHARLO
N

WATER RESOURCES AND TRANSPORTATION INFRASTRUCTURE	Date: 2006 03 31	Scale: 1 : 20 000	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT
	Job No.: 15830	Fig. No.: 3.8.1	NBDSS PROJECT No. YR101A

3.8.3.2.2 Post-dam and Existing Conditions

Municipal wastewater collection and treatment facilities are available to all of the communities of the Assessment Area. There are some rural areas, as well as remotely located residences within incorporated areas, that remain on private septic systems. However, most sewage produced within the Assessment Area is collected and treated. Wastewater collection and treatment facilities for municipalities within the Assessment Area are described below.

The Town of Dalhousie wastewater treatment facility was constructed in 1976. The system is a two cell aerated lagoon with two polishing ponds and a chlorination chamber. The treated water is discharged into Eel Bay via a submerged pipe 670 m from shore, south of the NB Power generating station (Richard and Godin, 2003). The collection system consists of eight lift stations, two of which are within the ERBFN reserve and have bypass pipes leading to Eel River estuary. These bypasses could allow untreated sewage to overflow into the Eel River estuary during periods of heavy precipitation or runoff when the Dalhousie system is overloaded. The treatment facility is undergoing an upgrade and will have the capacity to serve a population of 15,500. It presently serves the Town of Dalhousie, the ERBFN, and the Village of Eel River Crossing.

The Village of Eel River Crossing sewage lagoon, in operation since its construction in the mid-1970s, was decommissioned in June 2005 when the Village of Eel River Crossing sewage began being transferred via a sewer main to the Dalhousie sewage treatment facility.

The ERBFN now collects and transfers its sewage to the Dalhousie sewage treatment facility. Previously, the community was served by private septic tank systems.

The Village of Charlo constructed a sewage lagoon in the northwestern end of the Village in 1976. A 150 m outfall extends out into Eel Bay. The Blue Heron Campground has 36 toilets and 55 serviced lots that are connected to the Village of Charlo sewage collection system (Richard and Godin, 2003). The campground also has a dump station that is emptied by a pump truck as required.

The Village of Balmoral constructed a sewage lagoon at the eastern end of the Village in 1982, which outfalls into the South Branch of Eel River. Presently, this is the only remaining sewage treatment facility to discharge into Eel River, and the only system that relies upon the assimilative capacity of Eel River. The environmental effects related to this sewage lagoon are considered in Section 3.4.

3.9 Vessel Navigation

The *Navigable Waters Protection Act* (*NWPA*) indicates that "navigable water" includes a canal and any other body of water created or altered as a result of the construction of any work, where the waters are capable of being navigated by any type of floating vessel for the purpose of transportation, recreation, or commerce.

3.9.1.1 Pre-dam Conditions

Eel Bay is, and was before 1963, a shallow body of water. Depths in Eel Bay at the normal lowest tide, within 1 km of the shoreline, range between 0.5 m and approximately 5.0 m. Water depths in Eel Bay in 1986, measured in fathoms at normal lowest tide, are provided in Figure 3.1.1.

The Government of Canada, Department of Public Works, determined that the area under consideration for the Eel River Dam was navigable waters on April 23, 1963. This determination was based on the fact that canoes and small motor boats could navigate the area under high tide conditions. The Minister of Public Works authorized the construction of the Eel River Dam under the *NWPA*, on April 24, 1963.

Prior to construction of the dam, Eel River was not navigated for the purpose of commercial marine transportation service, with the exception of small fishing vessels serving the softshell clam and rainbow smelt fishery. Both the Eel River and Eel Bay were too shallow for most commercial vessels, even during high tides. The Port of Dalhousie provided commercial marine services to the area in the pre-dam period.

There was a channel from Eel Bay, past Eel River bar and through the Eel River estuary that was deep enough at all tidal stages to allow navigation by small power boats. However, recreational power boating on the river was limited even prior to construction of the dam (Madden, pers. comm.). Some canoeing did occur, however kayaking was not yet a common recreational activity prior to dam construction and therefore was not known to occur within the Eel River estuary.

3.9.1.2 Post-dam and Existing Conditions

Navigable waters exist above and below the dam, as defined in the *NWPA*, and the Eel River dam is a barrier to vessel navigation on Eel River in that vessels cannot navigate through or around the dam. Small vessels, such as canoes and kayaks, could be carried (portaged) over the dam. Navigation on Eel River has also been further limited by the Eel River dam because the channel opening under Route 134 on the Eel River bar has decreased from 100 m to approximately 30 m since 1963.

Access to the Eel River from Eel Bay by recreational powerboats is possible during high tide, but not during low tide prior to the construction of the dam, the main channel below the dam was navigable by small vessels under all tide conditions. By 1967, a DFO softshell clam survey observed that the dam construction had resulted in the infilling of the channel downstream of the dam to the extent that it was no longer navigable under the same tide conditions (Medcof, 1967). The channel within the Eel River estuary area is very narrow and difficult to navigate, so recreational power boating activity is limited. The dam obstructs passage upriver from the estuary. There is very little power boating in the impoundment due to the abundant aquatic vegetation growth, a result of the warm and nutrient rich waters of the impoundment, that become entangled in motor propellers, and the shallow depths.

Recreational canoeing and kayaking does occur in the impoundment above the dam, though none was observed during multiple field visits in 2004 and 2005, and therefore it is not likely a common or extensive use. There was a paddle boat rental shop and concession stand that operated on the shoreline of Eel River, in the Village of Eel River Crossing, during the late 1990s. However, business was insufficient to continue operation (Bujold, pers. comm.). Canoeists and kayakers that use the Eel River impoundment are typically boating enthusiasts, although some are bird watchers. Very few recreational fishers use boats, rather they prefer to fish sea-run brook trout from shore or in the water using hip-waders. The river narrows immediately above the Village of Eel River Crossing, where navigation is limited to canoes and kayaks.

There are presently no commercial marine transportation services provided on the Eel River or from the shores of Eel Bay. Commercial marine transportation services for the Assessment Area continue to be provided by the Port of Dalhousie, as well as by the Port of Belledune, established in 1968.

A tour boat service to Heron Island from the Eel River bar was operated by the ERBFN in recent years. However, due to problems associated with the shallow waters of Eel Bay at the Eel River bar, it was moved to a wharf at the Port of Dalhousie. The tour boat has since ceased operations and the boat has been sold (Goulette, pers. comm.). Other tour boats, such as the Chaleur Phantom, continue to operate out of the Port of Dalhousie.

3.10 Transportation Network

The Transportation Network includes both vehicle and rail right of ways. Although there are a number of local roads and streets within the Assessment Area (Section 2.2.3), the focus of this VEC is on the four provincial highways:

- Highway 11, from Route 275 to Route 230;
- Route 134, from Dalhousie to Charlo;
- Route 275, from Highway 11 to Route 280; and
- Route 280, from Route 275 to Route 134.

In addition to the vehicle network, there is a CN Rail line that crosses over the extreme western portion of the Eel River impoundment, in the Village of Eel River Crossing.

3.10.1 Traffic Patterns

3.10.1.1 Pre-dam Conditions

There are no traffic data for any of the provincial highway routes for the period prior to 1963. Highway 11 had not been constructed, therefore most of the traffic between Restigouche County coastal communities traveled by the old Highway 11, later re-designated Route 134 upon commissioning of the new Highway 11 alignment.

3.10.1.2 Post-dam and Existing Conditions

Traffic volume counts are undertaken on an annual basis by the NBDOT along most numbered highway routes. Traffic volumes are recorded in terms of the average annual daily traffic (AADT) at specific point locations along the highways. Within the Assessment Area, traffic volumes were available only for Highway 11 and Route 134.

The Highway 11 traffic count within the Assessment Area is located just east of the bridge over Eel River. The most recent (2003) traffic volume on Highway 11 is 3,370 AADT. This has grown from 2,050 AADT recorded in 1981, the first traffic count on this segment of Highway 11 following its commissioning in 1979.

The Route 134 NBDOT traffic count within the Assessment Area is located just east of Eel River bar. The most recent (2003) traffic volume on Route 134 at Eel River bar is 2,940 AADT. The earliest traffic count at this location was 3,890 AADT, recorded in 1975 and prior to construction of the new Highway 11. Traffic on Route 134 declined from 4,760 AADT in 1979 to 2,510 AADT in 1982, following completion of the new segment of Highway 11. Overall, traffic using these highways increased from 4,760 AADT in 1981/1982, to 6,310 AADT in 2003.

Both Highway 11 and Route 134 presently operate at Level of Service (LOS) B. LOS B conditions, as defined by the Transportation Research Board, USDOT, Highway Capacity Manual, 2000, for rural highways involve very good and stable flow operating conditions. Although the presence of other vehicles is apparent, the desired travel speed is relatively unaffected.

The traffic counts along Routes 275 and 280 at locations nearest to the Eel River are as follows:

- Route 275, southwest of Balmoral Village limits, 1,100 AADT; and
- Route 280, at Bernard Road, west of Eel River Crossing, 1,160 AADT.

Route 275 passes through the Village of Eel River Crossing. This segment of Route 275 within the Village is known as Rue Principale. Traffic volumes along Rue Principale are presumed to be higher than the section of Route 275, southwest of Balmoral, where the traffic count was recorded.

Table 3.10.1 presents a summary of the number of vehicular accidents along provincial highways within the Assessment Area from 1999 to 2003. The vehicle accidents are presented by three accident severity categories:

- PDO (accidents involving property damage only);
- Injury (accidents involving personal injury(ies)); and
- Fatal (accidents involving a fatality(ies)).

As presented in Table 3.10.1, the annual average accidents are generally fairly low on the provincial highways within the Assessment Area.

Table 3.10.1 Summary of Accident Occurrence by Severity - Assessment Area Highways (1999-2003)

Highway Routes	Total 5 Years				Annual Average			
	PDO	Injury	Fatal	Total	PDO	Injury	Fatal	Total
Highway 11	3	4	1	8	0.6	0.8	0.2	1.6
Route 134	10	4	0	14	2	0.8	0	2.8
Route 275	21	19	0	40	4.2	3.8	0	8
Route 280	5	2	2	9	1	0.4	0.4	1.8

There were three fatal accidents (two along Route 280) during the five year period. Most of the accidents involving personal injuries and property damage occurred along the Rue Principale section of Route 275 in the Village of Eel River Crossing.

3.10.2 Road Infrastructure

3.10.2.1 Pre-dam Conditions

Prior to construction of the Eel River dam, the present Route 134 was named Highway 11. There are no records available on condition of the highways prior to 1963. Access was not controlled along the three highway routes at that time (*i.e.*, Highway 11, Route 275, and Route 280).

The Route 134 Bridge at Eel River bar was constructed in 1956. It is 110 m long and remains as constructed. When constructed, the channel under the bridge was approximately 100 m wide. The three other bridges crossing Eel River have been constructed since the commissioning of the Eel River dam.

3.10.2.2 Post-dam and Existing Conditions

The NBDOT District 1 office provided information on the current condition of the four provincial highways within the Assessment Area (Jean, pers. comm.).

The Highway 11 Bridge over Eel River is a two-lane, pre-stressed concrete beam structure, 213 m long. It was constructed in 1979. Highway 11 is a well-constructed two-lane provincial arterial highway with good drainage, wide shoulders and arterial highway design standard. The asphalt surface has deteriorated, however, and there are plans to recap the surface in the near future. There has been no flooding experienced along Highway 11 or at the bridge over Eel River, and no damage by ice has been reported.

Route 134 was constructed along the coastline to serve local coastal communities. Route 134 is a provincial collector highway and it remains much as it was originally built. It is presently in good condition. Route 134 passes through the ERBFN Community and the Village of Charlo. The segment of Route 134 within the Assessment Area is two-lane with narrow paved and gravel shoulders. During recent storm surges (2000 and 2004), Eel River bar has been eroded and along this section of Route 134 the bayside road shoulder has been washed out. No damage to the roadway was experienced. Further east in the Village of Charlo, the armour stone seawall constructed between Route 134 and the Eel Bay shoreline was also damaged during recent storm surges. There is a concrete seawall in the vicinity of the intersection of Route 134 with Route 180 that has not been affected by storm surges to date.

The Route 134 bridge on Eel River bar is less exposed to Eel Bay storms (as compared to the bayside road shoulder) and has not experienced any damage to its structure or abutments from either storm or ice. The bridge is 110 m long and is a steel tied arch structure with a reinforced concrete slab bed. Deck repairs, and possibly structure upgrade, are planned for this bridge in the future. Currently, the channel opening under this bridge is approximately 30 m, reduced from the pre-dam size as a result of reduced tidal energy causing increased sedimentation in this area.

Route 275 is a provincial local highway. The segment of Route 275 within the Assessment Area is reported to be in fair condition. The surface will be recapped in the near future as part of normal maintenance. On Route 275, there are two bridges crossing Eel River. Both bridges are located within Eel River Crossing. One, the Le Couffe Bridge, is actually on a local municipal side street off of Rue Principale in Eel River Crossing. This bridge was constructed in 1966 and is a 36 m long steel truss structure. The second bridge, the Parrot Bridge, is actually on Route 275. It was constructed in 1982 and is a 20 m long concrete beam structure. There have been no reports of flooding along Route 275 or at the bridges.

Route 280 is a provincial local highway and is locally known as Cove Road. It is a chipsealed road and is reported to be in fair condition. No flooding has been experienced along the section of Route 280 within the Assessment Area.

The CN Rail line remains active at this location and carries both freight and passenger trains. There is a small bridge that crosses the Eel River impoundment and there are no known structural concerns with the bridge.

3.11 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

This section will discuss the use of the lands and resources as it has been documented in the living memory of the First Nation community at Eel River bar, bordering the Eel River dam to the north.

Prior to the construction of the Eel River dam, the local Aboriginal Community, the Eel River Bar First Nation (ERBFN), used the Eel River estuary and the surrounding lands for a number of traditional purposes. For presentation purposes only, these activities have been divided into the following activity categories: fisheries; trapping and hunting; plant gathering; recreation; and transportation and residential use. Each category includes a discussion of the status of the traditional activities before ("pre-dam") and after ("existing") the construction of the dam. Figure 3.11.1 illustrates some of the traditional land and water uses of this area before and after the dam.

3.11.1 Fisheries

3.11.1.1 Pre-dam Conditions

Prior to the dam construction, one of the primary uses of Eel River by the ERBFN was clam digging (Figure 3.11.1). This traditional activity served as both a subsistence activity and also brought in a significant percentage of income for the Reserve. According to the current ERBFN Chief, Thomas Everett Martin, this area was considered to be "one of the most productive softshell clam flats in the Maritimes (that) employed dozens of (ERBFN) citizens from spring through the fall" (Martin, 2004).

Prior to the construction of the dam, species such as eels, tomcod, brook trout, smelt, Atlantic salmon, herring and bass were all fished in the Eel River by members of the ERBFN. The majority of this fishing was undertaken for personal subsistence use (*i.e.*, food) and/or for barter or sale to local inhabitants and tourists (ERBFN, 2005a and 2005b; Indian Claims Commission Report, 1997).

The eel fishery remained active during the winter season, during which time mud spears (2-pronged spears) were used to catch the eels (ERBFN, 2005b). The eel fishery disappeared with the damming of Eel River.

The smelt fishery was reportedly lucrative prior to the construction of the ERBFN, 2005b). Historically, commercial smelt fishing took place in the Eel River and Restigouche River drainage areas and in the New Mills-Bengamin River area (across from Heron Island). Members of 12 Aboriginal families used approximately 9 box nets to fish smelt in Eel River. Eel River froze before Christmas, allowing good winter smelt fishing and availability of smelt at that time of year. In contrast, the Restigouche River drainage area would not freeze up until January, meaning that it was not possible to fish smelt in that area until after Christmas. In this way, fishers in Eel River had an advantage over those in the Restigouche River drainage area in terms of timely access to smelt.

3.11.1.2 Existing Conditions

The clam beds that remained after the substantial destruction of most of the clam beds following the construction of the dam (Medcof, 1967) were shut down in 1972 by DFO after excessive coliform counts were measured (MacNair, pers. comm.). After this fishery was re-opened, it was shut down once more by DFO in 1988 because the water was again contaminated by coliform bacteria from the treated sewage effluent from upstream communities being deposited into the river. The transition to freshwater conditions in the impoundment destroyed the clam populations in that area. Increased sedimentation associated with the reduced tidal flushing has also been shown to occur and which contriuted to substantial destruction of clam beds downstream of the dam (Medcof, 1967).

The smelt fishery in the Eel River impoundment area ceased immediately after dam construction (ERBFN, 2005b). Today, recreational smelt fishing takes place in the mouth of the Restigouche River, with commercial bag net fishing only in the channel of the Restigouche. Smelt are fished with traps in Eel Bay, close to Dalhousie, in January and February. Box nets would be lost if used in the winter smelt fishery in Eel River because the nets would freeze into the ice (ERBFN, 2005b).

Overall, fishing at Eel River by the ERBFN has declined since the construction of the dam. The dam is an impediment to fish migration and ERBFN navigation (ERBFN, 2005b). Eel and Atlantic salmon harvesting stopped shortly after construction, due to a reported decline in fish stocks. Prior to dam construction, smelts were plentiful in the area of the current impoundment, but are now fished in Eel Bay, close to Dalhousie. Trout are caught in the impoundment area for personal consumption. Tomcod were caught before the dam was built. Today, some tomcod are caught downstream of the dam, but generally they are fished further out in Eel Bay (ERBFN, 2005a and ERBFN, 2005b). The tomcod are caught in nets and sold to local fishermen as bait for lobster traps, which they use in both Eel Bay and Chaleur Bay (ERBFN, 2005a and ERBFN, 2005b).

3.11.2 Trapping and Hunting

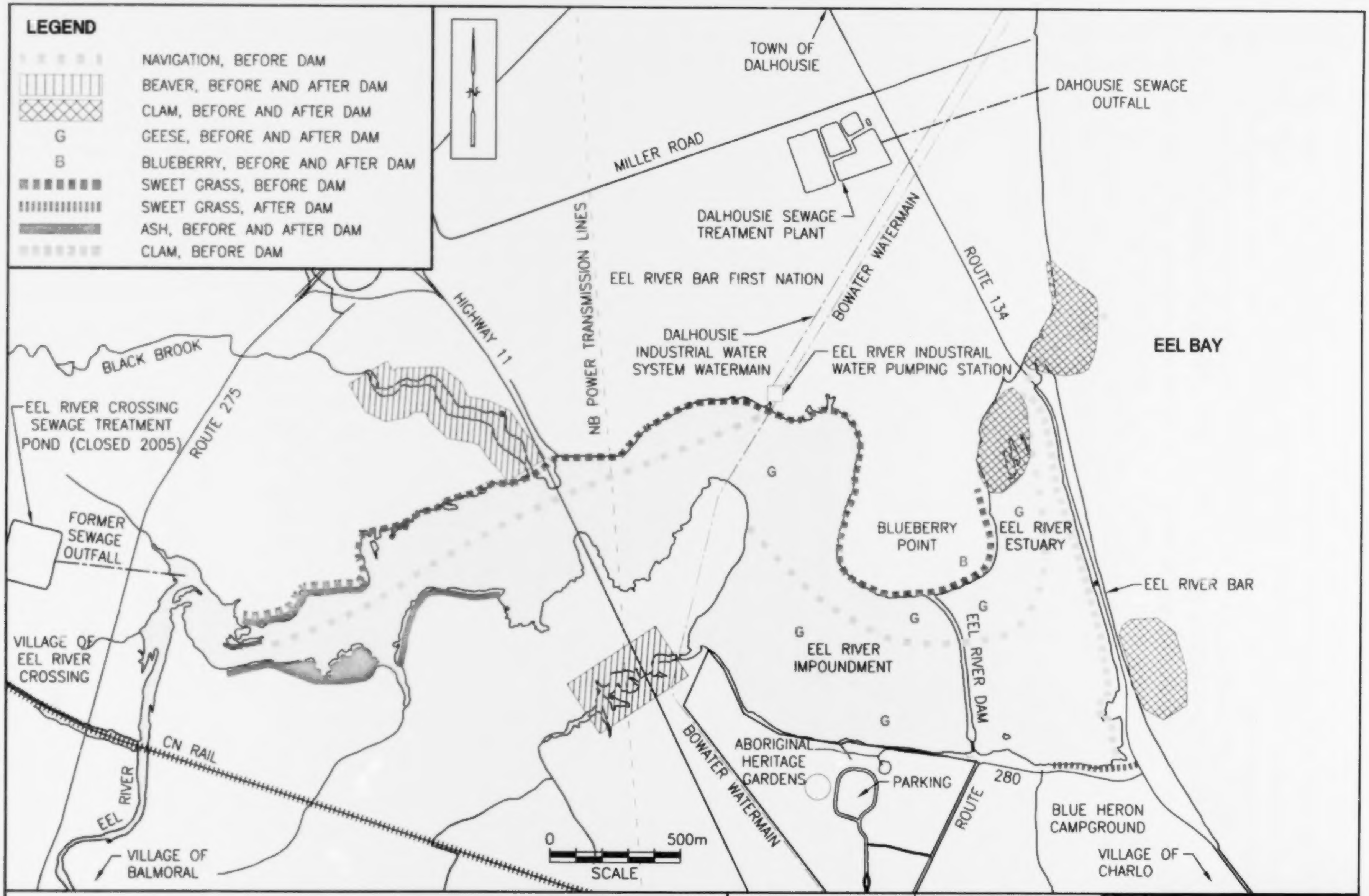
3.11.2.1 Pre-dam Conditions

The ERBFN report that hunting by its members took place along the river prior to dam construction; the hunted species included wild and brant geese, ducks, deer, bear and moose (Claims Commission Report, 1997; ERBFN, 2005a, ACOA website, 2003), however it is likely that other waterfowl were hunted as well. All historical, pre-dam marshlands were prime fowl hunting areas. (ERBFN, 2005a). The ERBFN report that trapping for rabbit, beaver and muskrats took place for food and pelts.

3.11.2.2 Existing Conditions

Today the marshlands are flooded as a result of the dam (ERBFN, 2005b). ERBFN members continue to hunt deer and moose for food and pelts. Geese and waterfowl hunting (black duck, mallard duck, and teal duck) still occurs, but most likely has diminished due to the proximity of residential development (ERBFN, 2005a and ERBFN, 2005b). The ERBFN report that geese, black duck, mallard duck, and teal duck, which are native to the Eel River bar area, are less abundant since the construction of the dam (ERBFN, 2005b). While populations of certain species have declined in number, there has not been a noted decline in the animal populations overall since the construction of the dam (ERBFN, 2005a).

FILE: 15830\EIA REPORT\LANDS-ABORIGINAL


LEGEND
NAVIGATION, BEFORE DAM
BEAVER, BEFORE AND AFTER DAM
CLAM, BEFORE AND AFTER DAM
G GEESE, BEFORE AND AFTER DAM
B BLUEBERRY, BEFORE AND AFTER DAM
SWEET GRASS, BEFORE DAM
SWEET GRASS, AFTER DAM
ASH, BEFORE AND AFTER DAM
CLAM, BEFORE DAM
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
NB POWER TRANSMISSION LINES
BOWATER WATERMAIN
ROUTE 134
EEL RIVER BAR FIRST NATION
HIGHWAY 11
EEL BAY
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
BLACK BROOK
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
ROUTE 275
FORMER SEWAGE OUTFALL
BLUEBERRY POINT
EEL RIVER ESTUARY
EEL RIVER BAR
VILLAGE OF EEL RIVER CROSSING
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
CN RAIL
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
BLUE HERON CAMPGROUND
EEL RIVER
VILLAGE OF BALMORAL
0 500m
SCALE
VILLAGE OF CHARLO

PAST AND CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES BY THE ABORIGINAL COMMUNITY

Date: 2006 03 31	Scale: 1 : 20 000
Job No.: 15830	Fig. No.: 3.11.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

Chief Thomas Everett Martin confirmed that "ecosystems have developed in the impoundment area (since the dam construction) including a very productive beaver and muskrat population." The New Brunswick Trappers claim the Eel River impoundment is "one of the finest trapping areas in the Province for beaver and muskrat" (ERBFN, 2004). Trapping is currently conducted along the shores and adjacent lands of the impoundment. However the majority of trapping in this area is conducted by non-Native individuals and groups. According to ERBFN, very little trapping has been done by its members in the past 15 years, due to a low economic return on pelts (ERBFN, 2005a). Although muskrat are present throughout the impoundment, beaver are restricted to Black Brook and the unnamed tributary across Eel River to the south (Figure 3.11.1).

3.11.3 Plant Gathering

3.11.3.1 Pre-Dam Conditions

The term "gathering" typically refers to the collecting of various plant species, and is reported to have taken place in the wetland areas along the shorelines of Eel River (in the current impoundment area) prior to dam construction (ERBFN, 2005b). This activity is seasonal and varies from species to species, depending upon the appropriate gathering time for each. Species are traditionally gathered for food, crafts and medicinal use.

Species that were reported as having been traditionally gathered include ash (*Fraxinus sp.*), blueberries (*Vaccinium angustifolium*), sweet grass (*Hierochloe odorata*), bear root, cranberries (*Vaccinium sp.*) and golden-thread (*Coptic trifoliate*), although many others were likely also collected. Sweet grass and blueberries were picked along the shores of what is now the impoundment and at Blueberry Point (Figure 3.11.1) prior to dam construction. The sweet grass was used for traditional ceremonies and to scent baskets. Several species of plants, growing in the blueberry patches, were used for medicinal and herbal purposes (Thibault, 2005). Bear root (in Mi'kmaq, "Gwisis") was collected and used as medicine for fevers by breaking off a piece and placing it in the mouth, or steeping it to make a tea (ERBFN, 2005a). Cranberry, used to control high blood pressure, and golden-thread, used for cancer therapy, were also collected and steeped into a tea. Other common medicinal plants used include teaberry (*Gaultheria procumbens*), alder (*Alnus sp.*), plantain (*Plantago major*), yellow water lily (*Nuphar lustrum*), cedar (*Thuja occidentalis*), and pitcher plants (*Sarracenia purpurea*) (Thibault, 2005). Firewood was collected from the island upstream of the current highway prior to dam construction. Ash trees were cut along the river and in marshy parts of the impoundment area prior to dam construction to make baskets and other crafts (ERBFN, 2005a). Bulrushes (*Scirpus sp.*) were also collected and used for making baskets (Thibault, 2005).

3.11.3.2 Existing Conditions

Gathering continues to be a First Nations land use activity, although reportedly at a reduced level. While vegetation grew along the beach during pre-dam conditions, the vegetation has eroded since construction of the dam and much of the land is flooded. Blueberries and sweet grass are still present, although apparently in diminished numbers. Sweet grass is only found along the south side of the impoundment now, approximately 300 metres from Cove Road (ERBFN, 2005a). The environmental effect of the construction of the dam on blueberry patches is less severe, as they grow above tide levels.

The ERBFN has stated that firewood is no longer required to heat the residential homes, and therefore is not frequently gathered. The gathering of sweet grass and ash trees are still important traditional activities, and blueberries are still harvested by about 20 to 30 people for personal consumption (ERBFN, 2005a and ERBFN, 2005b). The ERBFN reports that approximately 20 of their members currently make and sell ash baskets as well as moccasins made of deer pelts. The ERBFN states that they would like to see the sweet grass return after the removal of the dam (ERBFN, 2005a). The pre- and post-dam plant gathering locations as indicated by ERBFN are shown on Figure 3.11.1.

3.11.4 Recreation

3.11.4.1 Pre-dam Conditions

According to the ERBFN, the tidal inlet and estuary in Eel River was historically a popular regional swimming area prior to dam construction, because the river water was warmer than that of the bay (ERBFN, 2005a and ERBFN, 2005b). At low tide, people could dive into waters 2.5 m deep, and water holes 3 to 4.5 m deep that were located on the estuary side of the bridge on Route 134. Canoeing was also a popular recreational activity in Eel River prior to the construction of the dam (ERBFN, 2005a and ERBFN, 2005b).

3.11.4.2 Existing Conditions

Due to heavy sedimentation near the bridge, "children and young adults (are no longer able to) enjoy the recreational aspects of the river" such as swimming and diving, due to the shallow water (Martin, 2004). In addition, after the construction of the dam, over 15 acres of beach-front property along Eel River was lost due to erosion. Local First Nation residents do not currently swim in the impoundment area (ERBFN, 2005a).

Some of the current recreational activities of the ERBFN include gathering ash and sweet grass and picking blueberries. Canoeing continues to be done by ERBFN members in the summer. Although the Eel River area is generally a very active bird watching location, there are no avid bird watchers or guiding tours in the ERBFN. Past winter recreational activities in the area include snowmobile races and dog sled races (ERBFN, 2005a and ERBFN, 2005b).

Presently, the ERBFN is undertaking a major tourism project bordering on the Eel River impoundment. The Aboriginal Heritage Garden project will be located on 110 acres of undeveloped lands associated with Blue Heron Campground, and is scheduled to open in the summer of 2006. The project is being completed in conjunction with the Smithsonian Institution and the Canadian Museum of Nature, to celebrate the contributions of First Nations people to society, and to emphasize and promote the close relationship between Native culture and the environment. A significant portion of this project will involve showcasing the 270 species of medicinal plants that have traditionally been gathered and used by the First Nations people in this area. These plants are part of a large riparian type setting, with a few kilometres of trails and boardwalks that have been specifically designed to minimize environmental effects, while maximizing visibility for the varied species. First Nations interpreters who have knowledge of medicinal plants will be available to guide tours through the gardens (ACOA website, 2003).

In addition to tourism, this project is also designed to house specialized facilities in which scientists can undertake research under the guidance of the ERBFN Mi'kmaq elders. It is anticipated that the facility will initially employ at least 35 people during operating hours, with the future potential to employ as many as 80 people (ACOA website, 2003). The project will therefore create both economic and employment opportunities for the members of the community, as well as fostering and promoting traditional use of plant resources.

The Aboriginal Heritage Gardens project development plan calls for the clean-up of the Eel River impoundment, and the improvement of water quality at the mouth of Eel River to encourage recreational and eco-tourism related activities along the beaches (ERBFN, 1997). Although this project is not strictly traditional land use, it is anticipated that the improvement of this area will encourage the ERBFN community's return to use of this area for traditional purposes.

3.11.5 Transportation

3.11.5.1 Pre-dam Conditions

ERBFN confirms that the Eel River was used as a transportation route (Figure 3.11.1) prior to dam construction.

3.11.5.2 Existing Conditions

After the construction of the dam, the route from the mouth of the Eel River to the upstream sections was severed, effectively disrupting water-based transportation in the immediate area. Chief Martin reports, "One of the first apparent impacts of the dam (occurred) when boats could no longer enter the natural harbour during low tides after the channel was completely filled with sand and gravel" (Martin, 2004).

3.11.6 Residential Use

3.11.6.1 Pre-dam Conditions

The ERBFN have been living on the reserve at Eel River since it was granted to them in 1807.

3.11.6.2 Existing Conditions

Over 60 acres of land were lost due to flooding after the construction of the dam, in addition to an increase in the level of the water table, which has resulted in rendering portions of the ERBFN Reserve swamplike, and therefore unusable. Presently, due to shoreline erosion, the infrastructure of streets and homes closer to Eel River are threatened during extreme high water events such as storms and flooding (ERBFN, 1997; ACOA website, 2003).

3.11.7 Summary

3.11.7.1 Pre-dam Conditions

In summary, the traditional activities and land use of the Eel River bar area by members of the ERBFN prior to the construction of the dam consisted mainly of habitation, fishing, plant gathering, trapping and hunting. Eel River was also used by ERBFN for recreational purposes, and as a means of transportation.

3.11.7.2 Existing Conditions

The majority of traditional activities have declined or been stopped altogether since the construction of the dam. This is due in large part to contamination in Eel River, high levels of sedimentation and erosion, impediments to fish migration, an increase in water levels in the impoundment and surrounding shoreline, and a corresponding decline in the presence and availability of the plant, animal and fish species sought (ERBFN, 2005a and ERBFN, 2005b; Indian Claims Commission Report, 1997; Martin, 2004; ERBFN, 2004; ACOA website, 2003).

3.12 Tourism and Recreation

The Tourism and Recreation Assessment Area is located at the northwestern end of the Acadian Coastal Drive and at the northeastern end of the Appalachian Range Route tourism regions of New Brunswick. As such, the Assessment Area is associated with regional tourism attributes and attractions.

Figure 3.12.1 illustrates the existing Tourism and Recreation facilities in the portion of the Assessment Area surrounding Eel River. It should be noted that some tourism and recreation attributes and/or activities, such as bird watching, are not specific to a particular location and are not identified on the map. However, they are described in the following sections.

3.12.1 Tourism

3.12.1.1 Pre-dam Conditions

There was very little tourism developed within the Assessment Area (Section 2.2.3) in the years prior to construction of the Eel River dam in 1963. New Brunswick's Provincial Tourism Department was not established until the late 1970s, so tourism data are not available for the pre-dam period. However, local residents recall tourists coming through the area in great enough numbers to create a market for roadside sales of clams. Tourists were also drawn to the Eel River bar/Charlo beach area.

3.12.1.2 Post-dam Conditions

The Assessment Area is predominantly rural, and has not historically been a major tourist destination. Those tourists that did visit the Assessment Area came primarily for the use of the natural landscape and resources (*e.g.*, Eel River bar).

Charlo Beach is located on the coastal side of Eel River bar, a 1.6 km sand bar that divides the saltwater Eel Bay from the Eel River estuary. Charlo Beach has a seasonal, licensed seafood restaurant and take-out on the beach, as well as change rooms and washroom facilities.

Local accommodations for tourists include the Heron's Nest Cottages, located immediately across from the southern end of Eel River bar on the West Side of Route 134, and the Blue Heron Campground, located on the land of the former Chaleur Provincial Park between Route 180 and Route 134. The campground faces the Eel River dam and estuary, and also has a view of Eel Bay. The campground is a short walk to Charlo Beach, has a general store, 55 sites (serviced and unserviced), and offers vintage fire truck rides.

Eco-tourism is an existing commercial industry in the Assessment Area that has not been fully developed or strongly promoted although there is potential for further development. The Assessment Area offers opportunities for quality recreational and eco-tourism activities, including bird watching, recreational fishing, hiking trails, canoeing and kayaking the estuary, and swimming in Eel Bay. Previously, there was an Eel Bay tour boat/bird watching operation between Eel River bar and Heron Island, as well as a canoe, kayak and paddleboat rental shop and canteen in the Village of Eel River Crossing. Both have since ceased operation.

Multi-cultural diversity is a concept used as a tourist attraction to the Assessment Area based on the heritage of residents who are a diverse mix of cultural backgrounds including Acadian, First Nations, and British (particularly Scottish) heritages. Of particular note, the ERNFN has undertaken an ambitious effort to promote cultural based tourism in the Assessment Area. Following their economic development strategy called Destination 21st Century, the ERBFN has succeeded in many aspects including the opening of a full-service Osprey Park Truck Stop in early 2003 (ACOA website, 2003). Located on Highway 11, the Osprey Park Truck Stop tapped into growing truck traffic through northeast

New Brunswick. The truck stop is complete with a gas bar, a restaurant, a tourist information kiosk and other facilities and is a teepee design that affords some cultural link to Aboriginal-themed tourism. The ERBFN plans to use the truck stop as a promotion for the Aboriginal Heritage Gardens.

Aboriginal Heritage Gardens, scheduled for opening in the 2006 tourist season, will be a new cultural tourism destination located on the west side of Route 280 on the south side of the current Eel River impoundment, as seen in Figure 3.12.1. The Aboriginal Heritage Gardens were developed with the support of the Smithsonian Institute in the US and some Canadian museums. The following description of the Aboriginal Heritage Gardens was obtained from the ACOA website (2003).

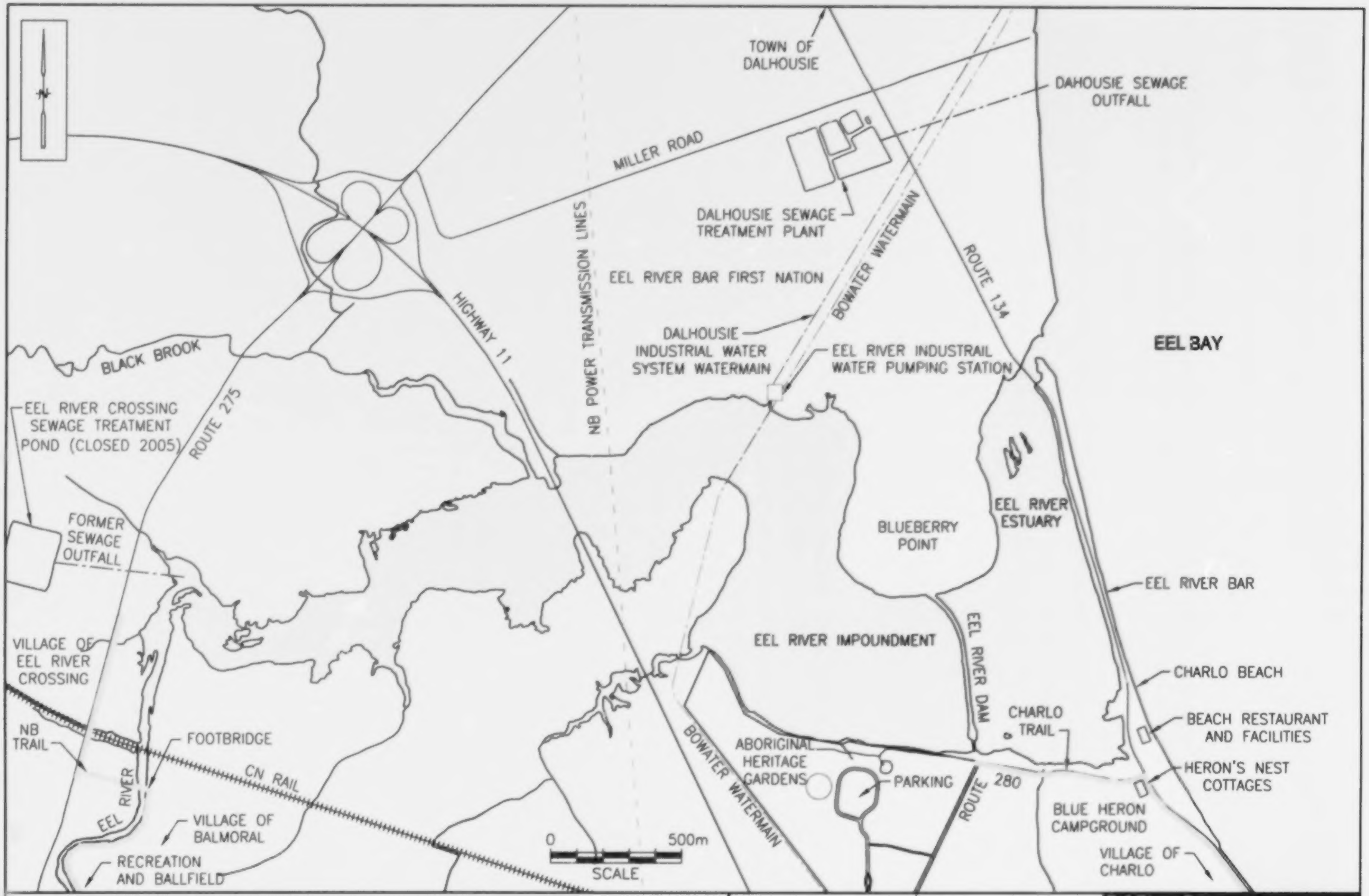
> *"The Aboriginal Heritage Gardens will showcase the plants from the land that have been traditionally used by the Aboriginal people for medicinal purposes. Some 270 species of medicinal plants have been identified for the gardens. Visitors will have access to approximately three kilometres of trails and board walks accessible from the gardens' main building, which will have an auditorium, souvenir shop and exhibits. Groups will be able to visit the trail with an aboriginal interpreter knowledgeable in the different medicinal plants. In addition, visitors will see clusters of colourful non-medicinal plants commemorating family groups from the First Nation. To date, there are eight of these commemorative clusters, comprising about 700 non-medicinal plants."*

The ERBFN anticipates eventual annual visitation of up to 80,000, comprised of both tourists and scientists/researchers from around the world (ACOA website, 2003). Interpretive signage are planned to be in English, French, Mi'kmaq, German, Italian and Japanese, and tours will be conducted in English and French. Ultimately, it is anticipated that the Aboriginal Heritage Gardens will complete a three-part heritage tourism circuit in New Brunswick, along with Village Historique Acadien and King's Landing (ACOA website, 2003).

The ERBFN has also recently undertaken the management of nearby Heron Island, in partnership with the Province of New Brunswick. Heron Island was historically a popular clam digging location with local residents (ACOA website, 2003).

Other cultural tourist attractions/events in the Assessment Area include the Eel River Pow-Wow, an annual Aboriginal cultural event of music, dance, and feasts hosted by the ERBFN. The Eel River Pow-Wow is held in July during the Mi'kmaq Cultural Days (ERBFN, 2005a).

FILE: 15830\EIA REPORT\TOURISM


N
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
DALHOUSIE SEWAGE TREATMENT PLANT
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
BOWATER WATERMAIN
ROUTE 134
HIGHWAY 11
EEL BAY
BLACK BROOK
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
ROUTE 275
EEL RIVER ESTUARY
BLUEBERRY POINT
FORMER SEWAGE OUTFALL
EEL RIVER BAR
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
VILLAGE OF EEL RIVER CROSSING
CHARLO BEACH
CHARLO TRAIL
BEACH RESTAURANT AND FACILITIES
NB TRAIL
FOOTBRIDGE
ABORIGINAL HERITAGE GARDENS
CN RAIL
PARKING
ROUTE 280
HERON'S NEST COTTAGES
BOWATER WATERMAIN
EEL RIVER
BLUE HERON CAMPGROUND
VILLAGE OF BALMORAL
0
500m
SCALE
VILLAGE OF CHARLO
RECREATION AND BALLFIELD

TOURISM AND RECREATION FACILITIES

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 3.12.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

3.12.2 Recreation

3.12.2.1 Pre-dam Conditions

In the years prior to construction of the Eel River dam, recreation activities such as hiking, bird watching, kayaking and canoeing were not common pursuits in the Assessment Area. However, motor boating, duck hunting, recreational fishing, swimming, and team sports such as baseball and hockey were popular at the time. At Eel River, people fished trout and salmon and dug clams for recreation and their own consumption. Anecdotal information indicates that there was also sport hunting, particularly for waterfowl, in the Eel River area (Clifford, pers. comm.). Swimming and jumping off the piers from the old bridge on Route 134 was also a popular recreation activity pre-dam construction.

3.12.2.2 Post-dam Conditions

There are a number of recreational activities and facilities within the Assessment Area. These are described below.

The Assessment Area is a very active bird watching location, particularly along the coast during the spring and fall migration. There are no formal bird lookouts, however many bird watchers go to the Blue Heron Park to observe birds by the dam or take the path along the Route 134 highway to observe birds in Eel Bay, particularly during spring migration. The Restigouche Naturalists' Club has approximately 25 members, a few of which observe birds on the Eel River.

As illustrated in Figure 3.12.1, there are a number of trails located within the Assessment Area. New Brunswick Trails Council Inc. (NB Trails) has a trail in Charlo that runs from Route 134, near Eel River bar, to the CN rail line and east to the Charlo River (McCluskey, pers. comm.). A municipal trail is located between the NB Trail and the Eel River dam and Blue Heron Campground. There is a trail over the Eel River dam to the ERBFN Reserve, although this is not an officially recognized trail (by the provincial NB Trails or municipally) and is not maintained. Currently, there are safety concerns with the unauthorized trail over the dam, particularly near the dam control structure where there is uncontrolled access. The Village of Eel River Crossing has a trail that runs along both sides of Eel River from the post office on Rue Principale to Route 180, connected by a footbridge at the end of Church Street (Bujold, pers. comm.). Bird watchers, hikers, and in the winter, snowmobilers, use these trails. There are also 3 km of hiking/walking trails at the Aboriginal Heritage Gardens.

There is limited power boating on the Eel River. The water is too shallow in the estuary below the dam and the aquatic vegetation growing in the impoundment above the dam clogs up boat motor propellers. However, canoeists and kayakers use the impoundment, and to a much lesser extent, the estuary. The lack of use in the estuary portion is likely due to the small available area (approximately 600 m). There are no marinas or boat landings on the Eel River impoundment or estuary, or on Eel Bay. Canoeists and kayakers access the impoundment at the bridge on Highway 11 or at the Blue Heron Campground.

Occasionally there is windsurfing and sailing on Eel Bay, however this is limited mainly due to the lack of a marina and the shallow waters near shore.

There is very little swimming in the Eel River impoundment or estuary areas. Nearby Charlo beach is a more desirable, and very busy, swimming and sunbathing beach used mainly by local residents, although tourists also use it. Jumping off the Route 134 bridge on Eel River bar and swimming in that area has ceased due to low water levels as a result of construction of the dam.

Traditionally Eel River had been a waterfowl hunting area, however few people hunt waterfowl there now. Muskrat trapping occurs around the impoundment, which was noted during Aboriginal meetings as a very good location for the trapping of muskrat and beaver.

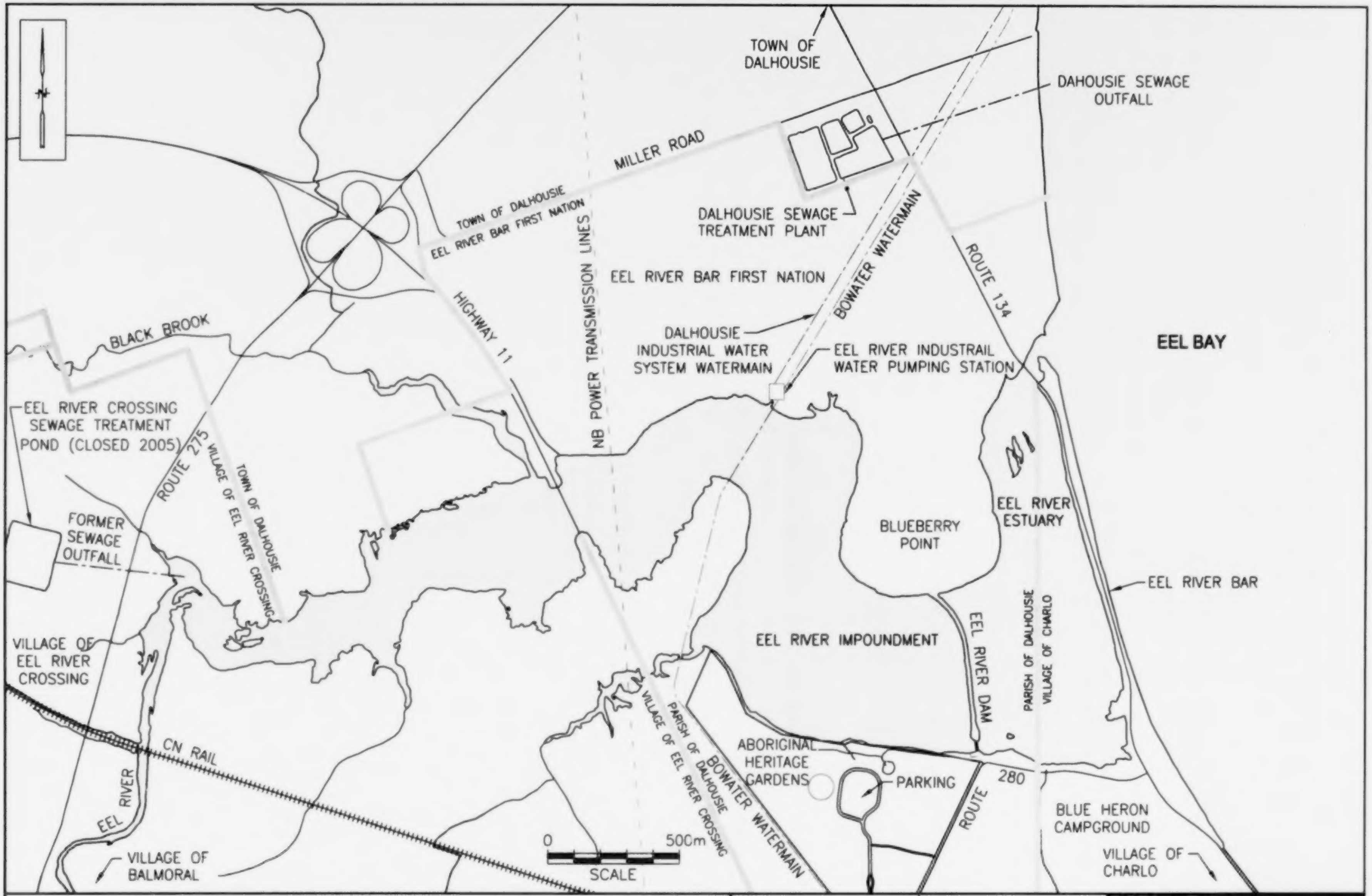
Most of the recreational fishing on Eel River is for sea-run brook trout and occurs in the immediate vicinity of the dam. This is likely a result of the dam acting as a partial barrier to the trout, thereby concentrating the fish immediately below the dam, and as a result of the access afforded by the adjacent vehicle parking lot. Above the dam, within the impoundment, recreational anglers fish from the shore. In the estuary below the dam, recreational anglers generally fish in the shallow water wearing hip-waders. Specific data on the brook trout fishery for Eel River are not available, however, Eel River is considered to have the most productive sports fishery for sea-run brook trout, in terms of numbers, of all streams between the Caraquet River and the Restigouche River (Madden, pers. comm.).

Recreational clam digging is not done much within the Eel River estuary at present because of the poor clam habitat conditions resulting from the dam and freshwater impoundment, and because of high levels of bacterial contamination (from contact with human sewage wastewater) reported since construction of the dam. At present, the clam fishery remains closed in the Eel River estuary and in Eel Bay by DFO as a result of the potential bacterial contamination by human sewage. This is discussed further in Public Health and Safety (Section 3.15).

3.13 Labour and Economy

The Labour and Economy Assessment Area is within Restigouche County and includes the Villages of Charlo, Eel River Crossing, Balmoral and the ERBFN, as well as portions of the parishes (Local Service District) of Balmoral and Dalhousie. The boundaries of these municipalities are shown in Figure 3.13.1.

FILE: 15830\EIA REPORT\MUNICIPAL


N
TOWN OF DALHOUSIE
DAHOUSIE SEWAGE OUTFALL
MILLER ROAD
TOWN OF DALHOUSIE
EEL RIVER BAR FIRST NATION
DALHOUSIE SEWAGE TREATMENT PLANT
NB POWER TRANSMISSION LINES
EEL RIVER BAR FIRST NATION
BOWATER WATERMAIN
ROUTE 134
HIGHWAY 11
BLACK BROOK
DALHOUSIE INDUSTRIAL WATER SYSTEM WATERMAIN
EEL RIVER INDUSTRAIL WATER PUMPING STATION
EEL BAY
EEL RIVER CROSSING SEWAGE TREATMENT POND (CLOSED 2005)
ROUTE 275
TOWN OF DALHOUSIE
VILLAGE OF EEL RIVER CROSSING
FORMER SEWAGE OUTFALL
EEL RIVER ESTUARY
BLUEBERRY POINT
EEL RIVER BAR
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
PARISH OF DALHOUSIE
VILLAGE OF CHARLO
VILLAGE OF EEL RIVER CROSSING
CN RAIL
PARISH OF DALHOUSIE
VILLAGE OF EEL RIVER CROSSING
BOWATER WATERMAIN
ABORIGINAL HERITAGE GARDENS
PARKING
ROUTE 280
BLUE HERON CAMPGROUND
EEL RIVER
VILLAGE OF BALMORAL
0
500m
SCALE
VILLAGE OF CHARLO

MUNICIPAL BOUNDARIES

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: **3.13.1**

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

3.13.1 Demographics, Labour Force and Economic Overview

3.13.1.1 Pre-dam Conditions

Prior to construction of the Eel River dam, the population of the Eel River Assessment Area was largely rural. The Villages of Charlo, Eel River Crossing, and Balmoral had not been incorporated, and municipal governments were county and parish based. The local economy of the Assessment Area was largely agriculture, forestry and fisheries. Some local residents worked at the mines, and at the pulp mills and smelters in the more urban centres of Town of Campbellton, the Town of Dalhousie, or the City of Bathurst.

3.13.1.2 Post-dam and Existing Conditions

Table 3.13.1 presents a recent demographic profile of the Assessment Area, including the 1996 and 2001 census populations, number of private dwellings, the land area, and the population density of New Brunswick in comparison with Restigouche County and communities of the Assessment Area. The total population of the Assessment Area in 2001 was approximately 5,000.

It is notable that from 1996 to 2001 the population of New Brunswick, Restigouche County as a whole, and the three Assessment Area villages all decreased. Only the ERBFN experienced a growth in population over the 5-year period. The ERBFN also had a lower median age of its population than the other geographic areas and a comparatively higher population density than the other municipalities, particularly in comparison to Restigouche County and the provincial average.

Table 3.13.1 Demographic Profile of Eel River Assessment Area

Characteristics	New Brunswick	Restigouche County	Eel River Bar First Nation	Village of Eel River Crossing	Village of Balmoral	Village of Charlo
Population in 2001 (persons)	729,498	36,134	299	1,335	1,836	1,449
Population in 1996 (persons)	738,133	38,701	281	1,446	1,975	1,610
1996 to 2001 population change (%)	-1.2	-6.6	6.4	-7.7	-7	-10
Total number of private dwellings	313,609	15,324	121	540	679	731
Population density in persons per km^2	10.2	4.2	191.6	76.6	42.2	47.1
Land area (km^2)	71,355.67	8,577.47	1.56	17.43	43.51	30.75
Median age of the population (years)	38.6	40.5	27.5	40	37.2	43.4

Source: Statistics Canada

Table 3.13.2 presents an economic labour force profile of the Assessment Area.

Table 3.13.2 Economic Labour Force Profile of Eel River Assessment Area

Characteristics	New Brunswick	Restigouche County	Eel River Bar First Nation	Village of Eel River Crossing	Village of Balmoral	Village of Charlo
Labour Force Indicators (%)						
Unemployment rate	12.5	18.5	25	16.2	5.9	19.4
Industry (person)						
Total – Experienced labour force	365,040	15,440	105	565	920	655
Agriculture and other resource-based industries	27,415	1,250	15	20	40	40
Manufacturing and construction industries	69,185	3,525	10	180	225	140
Wholesale and retail trade	53,625	2,070	0	135	165	84
Finance and real estate	14,800	530	10	10	25	35
Health and education	64,415	3,820	25	105	235	185
Business services	57,435	1,400	0	50	105	40
Other services	78,170	2,845	45	65	130	140
Occupation (persons)						
Total – Experienced labour force	365,040	15, 440	105	565	920	660
Management occupations	30,770	1,040	10	20	125	50
Business, finance and administration occupations	60,860	1,905	10	95	170	50
Natural and applied sciences and related occupations	17,965	490	10	10	20	35
Health occupations	20,185	1,360	0	20	70	65
Social science, education, government service and religion	24,560	1,110	20	50	75	100
Art, culture, recreation and sport	6,864	110	0	0	0	0
Sales and service occupations	95,795	4,295	30	165	205	165
Trades, transport and equipment operators and related occupations	61,300	2,800	10	134	155	165
Occupations unique to primary industry	20,845	890	25	10	35	20
Occupations unique to processing, manufacturing and utilities	25,890	1,440	0	85	70	10

Source: Statistics Canada

Restigouche County and its constituent municipalities have considerably higher unemployment rates than the provincial average, with the exception of the Village of Balmoral, where the unemployment rate of 5.9 percent was well below the provincial average unemployment rate of 12.5 percent in 2001. This is in contrast with the unemployment rate of 25 percent experienced in the ERBFN.

The breakdown of employment by industrial sector (Table 3.13.2) illustrates the declining proportions of resource-based industries relative to service sector industries. This phenomenon is in keeping with the trend among developed countries worldwide.

Despite the decline in resource harvesting based industries, the ERBFN has made many advancements towards improving the labour and economy status of the ERBFN community, and neighbouring communities, by focusing on a tourism based economy. The Osprey Park Truck Stop, opened in 2002, has generated substantial income and employment for the ERBFN. The Aboriginal Heritage Gardens, scheduled to open in 2006, will employ a staff of 35 during the first year, and may eventually expand its staff up to 80 persons (ACOA website, 2003). In addition, the ERBFN is in partnership with other industries (*e.g.*, Kan-ga-roo Playgrounds), and is in the process of developing its own chain of coffee shops. The ERBFN also operates a passenger vessel taking tourists to and from Heron Island during summer months, and recently hosted the fencing event of the 2003 Canada Winter Games.

3.13.2 Commercial Fisheries Resources

The Eel River watershed and estuary has been and, in some cases, continues to be the site of productive commercial fisheries.

3.13.2.1 Pre-dam Conditions

Historically softshell clams were dug with forks and shovels in the Eel River estuary and Eel Bay. In the early 1960s clams were very plentiful and a 6 quart pail (approximately 7.6 litres) of clams could be filled in 30 minutes to an hour between tides. Prior to 1963, clam production probably extended slightly upstream of its present upstream boundary, which is the Eel River dam. Table 3.13.3 provides harvest data for clams pre-dam construction, in the late 1950s and early 1960s.

Clams were abundant in the Eel River estuary and local area residents commonly dug clams for sale and for personal consumption. Clam digging was more of a "cottage industry" than a production industry. There was no local processing plant or market distribution system. Residents generally dug clams independently and sold them roadside, fresh and steamed. Some residents took them to sell in urban markets in the Town of St. Stephen or to the processing plant in the Town of Bouctouche.

In 1963, clams sold for $1.50 for a six-quart pail roadside. At that time, the total potential clam harvest out of the Eel River estuary, according to a 1963 survey (MacPhail, 1964), was estimated to be 77,000 six-quart pails of marketable clams. This was, in 1963 dollars, a value of $115,000. In 2004 dollars (in Consumer Price Index equivalent) this was equivalent to almost $750,000.

A six-quart pail of clams would sell today for approximately $10. One First Nation resident reported that he had sold 70 six-quart pails of clams in one weekend during the one-week clam survey in 1963 (MacPhail, 1964). In 2004 dollars, this would be equivalent to almost $700 for the weekend.

Table 3.13.3 Estimated Landings of Softshell Clams (kg) at Eel River Cove, New Brunswick, 1959 to 1962

	1959	1960	1961	1962
April	0	907	408	1133
May	907	2268	2495	1360
June	3401	3992	3629	4218
July	4535	5670	6804	2358
August	4082	9979	1905	997
September	2041	4536	2495	430
October	2013	1225	499	430
November	793	635	0	680
December	0	0	0	544
Totals	17772	29212	18235	12150
Estimated value in early 1960s dollars	$3,920	$6,440	$4,020	$2,680

Source: MacPhail, 1964

American Eel were speared by ERBFN members in the Eel River estuary and at the inlet prior to the bridge replacement in 1956. Eels were caught for both personal consumption and bartering (ERBFN, 2005b).

Rainbow smelt were fished with nets in Eel River estuary prior to dam construction. A total of approximately 20 box nets were used to fish smelt (ERBFN, 2005b). Half of the fishers were native, while the other half were non-native. Historical commercial smelt fishing took place in the Eel River and Restigouche drainage areas and in the New Mills-Benjamin River area (across from Heron Island). Smelt were plentiful in the Eel River estuary prior to dam construction.

Atlantic salmon were fished with trap nets for personal and commercial consumption between May and July pre-dam construction, including in the tidal inlet area of the estuary.

Atlantic tomcod were caught in Eel River prior to dam construction and were sold commercially, probably for use in producing animal food.

3.13.2.2 Post-dam and Existing Conditions

The estuary below the dam, has an area of 36.4 ha. Almost all of it, with the exception of the gravel bars near its mouth, supported the production of the commercially and recreationally important mollusc, the softshell clam. Within one year of the construction of the dam, the boundaries of the clam-flats that provided a feasibly harvestable population had not perceptively changed (MacPhail, 1964).

By 1967 the clam harvest had declined by 70 percent and the clam fishery was closed in 1972 due to contamination of the clams with *E. coli* bacteria (MacNair, pers. comm.). The economic loss to residents of the area, particularly the ERBFN, was accentuated by the cultural loss associated with the end of clam digging activity.

There is still a large biomass of clams in the Eel River estuary. However, due to fecal coliform contamination in the water (Section 3.15), the fishery for clams at this site has been closed since 1988 (Godin, pers. comm.). In addition, accumulation of substantial sediment (*i.e.*, up to 1 m in some places) began to occur on the clam beds immediately following dam construction and continuing through to present day (Haché, pers. comm.). Table 3.13.4 provides comparative clam standing crop data for the Eel River estuary and the estuary below the dam for the immediately pre-dam and post-dam periods.

Table 3.13.4 Comparative Numbers and Weight of Clams, 1963, 1964 and 1967

Section No.	1	2	3	4	5	6	Totals
Area (ha)	4	3.2	2.8	2.4	2	1.5	15.9
Length (mm)	Number of Clams						
50-55	1,708	2,571	2,666	1,710	799	484	9,938
55-60	1,154	2,115	2,402	3,406	196	509	9,782
60-65	491	193	1,021	2,483	376	371	4,935
65-70	323	508	449	1,637	330	611	3,858
Number of Pails							
1967 Totals	3,676	5,387	6,538	9,236	1,701	1,975	28,513
1964 Totals	15,169	9,987	6,263	9,234	5,218	2,770	48,641
1963 Totals	20,392	16,391	19,934	11,312	6,793	2,215	77,017
Mass (kg)							
1967 Totals	25,011	36,653	44,484	62,841	11,573	13,438	193,999
1964 Totals	103,208	67,950	42,613	62,827	35,503	18,847	330,948
1963 Totals	138,745	111,523	135,629	76,966	46,219	15,071	524,015
Ratio 1967 of 1963	18.0%	32.9%	32.8%	81.6%	25.0%	89.2%	37.0%

Source: Medcof, 1967

Since the late 1960s, the standing crop of the clam resource does not appear to have changed substantially despite little or no harvesting occurring. Fieldwork conducted in 2004 as part of this EIA is summarized in Table 3.13.5.

Table 3.13.5 Summary of Clam Standing Crops in the estuary below the dam

2004 Survey		Summary of Known Surveys (Legal size only*)	
Total Area (m^2)	368,103	1963 Total Weight (kg)	541,112
Total Area (ha)	36.8	1964 Total Weight (kg)	347,640
Total Area (acres)	91.0	1967 Total Weight (kg)	210,404
Number of Legal Clams	10,167,733	2004 Total Weight (kg)	224,234
Number of Sub-legal Clams	20,328,051	(*): Note: 1960s data adjusted for non-sampled areas	
Weight (kg) Legal Clams	224,234		
Weight (kg) Sub-legal Clams	98,393		
Total Weight (kg)	322,627		

Source: Jacques Whitford Study Team

The American Eel fishery stopped shortly after dam construction.

Today, recreational rainbow smelt fishing takes place in the mouth of the Restigouche, with commercial bag net fishing only in the channel of the Restigouche. Smelt are fished with traps in Eel Bay, close to

Dalhousie, in January and February. The smelt fishery in the Eel River impoundment ceased immediately after dam construction (ERBFN, 2005b).

Atlantic Salmon were fished with trap nets for personal and commercial consumption between May and July during the post-dam period, including in the tidal inlet area of the estuary. Salmon fishing licenses held by the ERBFN were sold back to DFO in the 1970s. Under DFO's current regulations, salmon used for food and ceremonial purposes are no longer fished by ERBFN. The ERBFN continue to manage a fish hatchery in Charlo, and are investigating the potential of diversifying into oyster farming (ACOA website, 2003).

Presently, some tomcod are caught near the downstream side of the dam, but generally they are fished further out in Eel Bay (ERBFN, 2005b). The tomcod are caught in nets and sold to local fishermen as bait for lobster traps.

3.14 Archeological and Heritage Resources

In order to determine the current condition of the archaeological and heritage resources in the area of potential influence of the Project, an analysis of the pre-dam and existing conditions was required. This was accomplished through a Heritage Resource Evaluation, in which known resources were assessed through a review of the provincial heritage records, provincial archives, documented archaeological sites, published and unpublished documentary and cartographic (relating to chart- or map-making) sources, historic aerial photographs and communication with local informants, community historians, and local First Nations people.

The provincial databases maintained by the Heritage Branch of the Province of New Brunswick (including the Archaeological Site File, the Borden Map File, the Heritage Place Register, The Canadian Register of Historic Buildings, and the Archaeological Projects Manuscripts File) were reviewed to identify areas containing known archaeological or heritage resources.

Historical mapping and archival information maintained by the New Brunswick Provincial Archives were reviewed in order to establish the location of the shoreline and associated buildings during various historic periods. A document review was conducted, including published and unpublished reports of archaeological and heritage investigations, and local, regional and provincial historical texts.

Topographic and geological mapping, in addition to aerial photography, was reviewed to identify cultural and historical characteristics commonly associated with archaeological and heritage sites in the region. This technique is known as predictive modelling.

3.14.1 Pre-dam Conditions

The region of Chaleur Bay has been the site of human activity for thousands of years. With its numerous associated waterways and tributaries, the areas surrounding Chaleur Bay would have been a major focal point for transportation and travel in northern New Brunswick, and would have provided an excellent location for settlement, both temporary and permanent. It is highly probable that Eel River was an integral part of this system.

Approximately five thousand years ago, the sea levels surrounding what is now New Brunswick were lower, and coastal portions of larger watercourses would likely have been significantly narrower than they appear today. As sea levels rose, many areas that were previously shorelines became flooded and were no longer available for habitation or other uses by First Nation people living in those areas. The exact nature of the effects of this flooding of the previous shoreline areas is not clear, however, it is possible that there are archaeological sites still present in these inundated areas. An examination of the Eel River basin reveals a deeper channel with shallower (1-2 m deep) sections of the river bounding that main channel. These shallow areas could represent submerged floodplains (*i.e.*, paleo-shorelines) located adjacent to the original deeper channel of the river. Therefore, it is possible for these submerged areas to contain pre-contact archaeological sites.

During the pre-contact period, this region of modern New Brunswick was populated by indigenous Mi'kmaq groups, who would have used the rivers and adjacent lands for resource and food procurement, in addition to transportation. The ancestors of the Mi'kmaq were semi-nomadic communities who varied their habitation sites and activities seasonally (Ganong, 1899; Clarke, 1994).

The Contact period in northern New Brunswick was characterized primarily by European exploration and fishing expeditions throughout the 16th century, followed by permanent European settlement beginning in the 17th century. Historical settlements also gravitated towards the coastal areas and river shorelines, resulting in the formation of towns and villages such as the nearby town of Dalhousie. It is well documented that the proliferation of clam beds, eels and other marine animals in the immediate area were considered a valuable resource to both the Aboriginal and European inhabitants of Eel River.

There are undoubtedly a number of unrecorded First Nations archaeological sites at the mouth and along the banks of the Eel River, since both small and large sites of this nature are present along most of the other navigable waterways in New Brunswick that have been surveyed for heritage resources. To date, only one professional archaeological survey has been conducted along the northeastern coast of New Brunswick (Martijn, 1968). Since that time, a limited number of archaeological sites have been recorded in the Chaleur Bay region, however no recent comprehensive survey has been conducted, and, therefore, the current status and number of surviving pre-contact sites is not known.

It should be noted that the water levels in the current impoundment area of the dam were lower prior to the construction of that dam (having risen as a result of the dam), and therefore, similar to the sea-level rise situation, many of the formerly exposed floodplain areas along the Eel River shorelines are now submerged. In addition, a number of small islands within the channel of Eel River have been submerged, all of which appear to have been above the water level in aerial photographs dating from 1955. A period of uncharacteristically low water levels in the summer of 2005 revealed a similar configuration of floodplain and island areas as seen on the 1955 aerial photographs. This evidence, coupled with the knowledge that sea levels were at least a few metres lower three thousand to five thousand years ago, suggests that these currently inundated shoreline areas and islands would have a very high potential for pre-contact archaeological resources.

Since the only known professional archaeological survey was conducted in 1968, after the Eel River dam had been constructed, there are few known records of archaeological sites along the river prior to dam construction, although this lack of recording should not be considered indicative of an absence of archaeological resources at this location. Martijn notes that Dr. David Sanger at the National Museum of Canada (now the Canadian Museum of Civilization) was in possession of a report filed prior to World War I of a shell midden (a deposit containing shells, animal bones, and other refuse indicating the site of a prehistoric human settlement) approximately 1.5 km southeast of Dalhousie, on the property of Mr. Charles Stewart. A collection of artifacts from this midden are kept at the museum. Martijn located the site in what had become the Inch Arran municipal camping grounds, and recounts that the area had been extensively disturbed by agricultural activity. The terrace was archaeologically tested during the 1968 survey, however no archaeological material was encountered.

3.14.2 Existing Conditions

Archaeological and heritage resources that were considered within this study consisted of any standing, surface or subsurface remnants from past human activities within the Eel River Assessment Area.

It is unknown how many archaeological sites may have been submerged or eroded by the changing water levels in the Eel River, particularly in the area of the current impoundment. In addition to the rising water levels, the channel of the river has shifted from the northern side of the impoundment (where it was originally located around Blueberry Point) to the southern edge of the impoundment due to the location of the control structure. This migration of the channel may have eliminated some of the archaeological sites within that submerged floodplain area, particularly older pre-contact sites that may have been in areas located above the sea level in the past. It is not known whether these currently submerged floodplain areas would have been suitable for habitation within the past three or four centuries.

Martijn (1968) writes: "*The mouth of the Eel River has suffered considerable disturbance due to road and bridge construction as well as the erection of houses on the Indian Reservation. In addition to this the Eel River bar is now deluged by thousand of people on weekends during the course of the summer since it provides a long beach area and excellent clam digging. Further upstream on the Eel River a dam has been constructed, flooding all the beaches for some distance upriver and causing the river itself to become gradually choked up with weeds.*"

Since construction of the dam, three other archaeological sites have been recorded within 10 km of the dam location, in the region surrounding Eel River. Two of these sites are Pre-contact/Contact period in nature and were located during the 1968 survey of the coastal shoreline (Martijn 1968). The third recorded site is a historic cellar feature in the Dalhousie area. None of the recorded sites are anticipated to be affected by the Project.

It is highly likely that a significant number of unrecorded and/or unidentified archaeological sites still remain along the pre-dam shorelines of Eel River despite construction of the dam. However, the ongoing process of urban renewal, and the continuing growth of the communities along Eel River and its tributaries may have covered or otherwise affected some First Nations and historic period archaeological sites. The removal of the Eel River dam may cause some currently submerged shoreline and island areas containing archaeological resources to be exposed, at least at low tide, thereby revealing more of the archaeological potential of the Assessment Area.

3.15 Public Health and Safety

3.15.1 Flooding and Flood Risk

The flooding of property as a result of precipitation, the spring freshet, high tides, and/or storm surge, can present a risk to the health of humans in the Assessment Area.

3.15.1.1 Pre-dam Conditions

Prior to construction of the dam, some areas proximal to the river in the Assessment Area were prone to occasional flooding during higher than normal tides. Residents of the Village of Eel River Crossing recall the ballfield adjacent to Eel River at times being flooded by occasional extreme high tide (Bujold, pers. comm.). Pre-dam conditions were such that the tidal flow was not restricted. The tidal water level could, on occasions, have been higher than the water level typically maintained in the impoundment for post-dam or current conditions. The highest tide ever recorded at the Dalhousie station in 1964 and from 1973 to 1992 is 2.36 m, which occurred on October 26, 1980. The impoundment is currently maintained at an elevation of 1.98 m. However, any flooding caused by extreme high tide under pre-dam conditions would be short in duration because the water level would subsequently fall during the lowering cycle of the tide.

As a consequence of constructing the Eel River dam, the Province of New Brunswick purchased properties adjacent to the impoundment and river in the Village of Eel River Crossing because of potential flooding risks. Some homes were relocated more inland and further away from the river banks and shoreline. This appears to indicate that the typical high water level in the Eel River estuary prior to the construction of the dam was lower and generally below the currently maintained water level of the impoundment (*i.e.*, below 1.98 m).

3.15.1.2 Post-dam and Existing Conditions

After the construction of the dam, flooding upstream of the dam in the area of the ballfield in the Village of Eel River Crossing still occurred (Bujold, pers. comm.). This is attributed to high river flow associated with events of high precipitation and spring ice break up and runoff. The Town of Dalhousie is responsible for operating the gates. There is no gate management plan in place other than maintaining the water level in the impoundment below the maximum normal operating level of 1.98 m.

The water level in the impoundment is currently regulated by the six gates in the water control structure of the dam located at the southern end of the Eel River dam, which also protects the impoundment area from flooding by extreme high tides overtopping the gates and entering the impoundment. During a dam modification in 1968 and 1969, the potential storage capacity of the impoundment was increased by 1.0 m (BMA and CG&S, 2000), which would increase the maximum operating water level from 1.98 m to 2.98 m, including higher risks to potential flooding. It is not known if the impoundment has been operated at this level. Design information regarding the selection of this maximum operating water level is not available.

Generally, in the spring the steel gates in the control structure of the dam are opened by the Town of Dalhousie primarily to control flooding upstream at the Village of Eel River Crossing, but also to permit upstream fish passage migration. In the spring generally one steel gate is opened fully with a second steel gate opened to the halfway position. No gates are opened in the winter, and in the summer the gates are usually closed and opened only during periods of heavy rainfall. In the summer there is no flow through the dam except through the opened slot of the fishway (Guitard, pers. comm.). Flooding risk is generally as a result of high water levels upstream of the dam not responding rapidly to gate openings, or the time lag between the gates being opened on site by an operator in response to rising water levels upstream of the dam. There is no automatic detection to warn high water levels upstream of the dam or automatic gate openings. This is all accomplished manually by an operator from the Town of Dalhousie.

3.15.2 Bacteriological Environment

Fecal coliform and *E. coli* bacteria do not directly affect aquatic life, but are indicators of water quality as they imply the degree of contamination by human or animal waste and the potential for transmission of microbial pathogens to aquatic animals and humans that may be associated with these wastes. It is an important key variable to assess and as a key indicator for public health and safety issues related to sewage, outfalls and tributaries.

The presence of *E. coli* is clearly undesirable in surface water that is used in a surface water supply. *E. coli* is an indicator of fecal contamination, and as such may signal the potential presence of pathogenic microbes or parasites, including bacteria, viruses, or protozoa. In addition, some strains of *E. coli* can cause fatal illness in humans. Therefore although the Village of Eel River Crossing uses an infiltration gallery to obtain raw water from the Eel River, and treats this water with chlorine as a disinfecting agent prior to distribution, the presence of *E. coli* in the raw water is undesirable and steps should be taken to identify and eliminate the source.

3.15.2.1 Pre-dam Conditions

There is no available information on bacteria and fecal coliforms for pre-dam conditions. It is anticipated that Eel River received sewage and wastewater from several point and non-point sources for decades pre-dating the construction of the dam with the use of septic systems and direct discharges. The sewage collection and treatment systems for the ERBFN, Villages of Eel River Crossing and Balmoral and the Town of Dalhousie were not yet implemented prior to the construction of the dam in 1963. Further, any coliforms and discharges into Eel River would have been diluted in a free-flowing river and flushed twice daily in the estuary with a higher tidal volume under pre-dam conditions in contrast to post-dam and existing conditions.

3.15.2.2 Post-dam and Existing Conditions

Sources of fecal coliforms and *E. coli* bacteria after the construction of the dam in 1963 can be mostly attributed to the Villages of Balmoral and Eel River Crossing wastewater treatment ponds discharging effluent and overflow directly through outfalls into Eel River. Dundee (Unincorporated) further up on Eel River relies on private septic systems for disposal of domestic sewage, with potential seepage into the Eel River watershed as non-point sources. The Village of Balmoral's wastewater treatment pond (WWTP) started operation in 1981. The outfall from this treatment facility is situated on the south branch of Eel River. The sewage effluent flows along sections of rapids on this branch and eventually flows into the main branch of Eel River at the location immediately adjacent and downstream of the ballfields, but upriver to the Village of Eel River Crossing. The Village of Eel River Crossing's WWTP started operation in 1975. However, the Village of Eel River Crossing's WWTP stopped operation and all discharges into the main branch of Eel River in June 2005 because the village's wastewater system is now connected with that of the Town of Dalhousie. The Town of Dalhousie's WWTP discharges through an outfall 670 m from shore into Chaleur Bay (see Section 3.8.3 for more detailed information on Wastewater Treatment Infrastructure).

Aquatic surveys were carried out on the Eel River (main branch) on November 5, 2003 and November 24, 2003 (Jacques Whitford, 2003). The survey conducted on November 5, 2003 included water quality sampling at six stations located on the Eel River at the Village of Eel River Crossing water intake pumping station, river crossings at Splude Road and Bernard Road, and at a fork in the river further upstream from Splude Road. In addition, a sampling station was also located downstream of the village sewage lagoon outfall in Eel River. A purpose of this survey was to identify any activities or point sources that might be responsible for water quality impairment. The survey on November 24, 2003, was more specific and focussed on the section of river between Bernard Road and Splude Road. This survey involved sampling at 14 stations located at selected points along the river. All in-flowing tributaries, surface run-off points and culverts throughout the reach were sampled for total coliform/*E. coli* concentrations. The second survey conducted on November 24, 2003 was intended to identify the source of *E. coli* contamination.

Sampling data from November 5, 2003 indicate substantial increase in the concentration of *E. coli* bacteria existed between the stations at Bernard Road and Splude Road in Dundee (Unincorporated). Between these two stations *E. coli* concentrations increased from 60/100 mL to 993/100 mL and increased further to a concentration of 1,109/100 mL at the village pump station. The *E. coli* concentration in Eel River at the site of the Village of Eel River Crossing sewage lagoon outfall when it was in operation at that time was much higher at 12,724/100 mL. These concentrations are significantly higher than CCME guidelines for recreational water standards (CCME, 1998) which state that *E. coli* concentrations in recreational waters should not exceed 200/100 mL (CCME, 1998). Because of these results, the second survey on November 24, 2003 was conducted to determine the point source of the *E. coli* contamination between Bernard Road and Splude Road.

Results of the second survey conducted on November 24, 2003 indicated *E. coli* concentrations were within acceptable CCME (1998) range for recreational water of less than 200/100 mL throughout most of the sampling reach in Eel River between Bernard Road and Splude Road. The final sampling station however, located at a culvert just upstream of Bernard Road bridge and discharging into Eel River, contained an *E. coli* concentration of 2,492/100 mL. The culvert was found to be a source of high *E. coli* concentrations in water. It is also important to note that these *E. coli* counts were obtained when the water temperatures were low and not ideal for bacterial survival. It can be assumed that *E. coli* counts could be higher during the summer, when warmer water temperatures would lengthen survival times.

NBENV (Fox, pers. comm.) measured *E. coli* in the upper reaches of Eel River above Dundee (Unincorporated) from May to November 2004. Out of 26 water samples analyzed, 14 were less than the detection limit of 10 cells/100 mL. The remaining 12 samples above the detection limit had a mean *E. coli* concentration of 89/100 mL and ranged from a minimum of 10/100 mL to a maximum of 290/100 mL.

Environment Canada sampled for fecal coliforms upstream of the dam in Eel River, the estuary and along the coastline in Eel Bay in 1987, 1999 and 2002. This survey is part of their routine re-evaluation of the bacteriological water quality and classification of shellfish growing areas from the Restigouche River to Grande-Rivière Tracadie, in north eastern New Brunswick (Richard and Godin, 2003). These studies are carried out by Environment Canada to ensure that the water quality of approved shellfish growing areas remains acceptable for the harvesting of molluscan shellfish for direct marketing. From a public health standpoint, the principal purpose is to detect the occurrence of disease-causing organisms that may be accumulated by shellfish if domestic sewage or animal wastes reach their environment.

The public health safety of shellfish and shellfish harvesting waters in Canada is judged presently by bacteriological standards. These standards require that the "*most probable number (MPN) of fecal coliforms in water not exceed a median or geometric mean of 14 per 100mL and that no more than 10 percent of the samples exceed 43 fecal coliforms per 100mL in areas approved for shellfish harvesting*" (Richard and Godin, 2003).

The location of Environment Canada's sampling stations in the Eel River-Charlo area are shown in Figure 3.15.1 and the concentration of fecal coliforms measured at these stations in 1987, 1999 and 2002, and prior to decommissioning the Village of Eel River Crossing WWTP, is given in Table 3.15.1.

Table 3.15.1 **Summary Statistics of Fecal Coliform Concentrations (Most Probable Number/100 mL) for Eel River**

Station	Samples	Period	Minimum Fecal Coliform	Maximum Fecal Coliform	Geometric Mean	Median	P90	%>43
2	11	1987-2002	1.9	350	7	1.9	105	27
A2	4	2002-2002	1.9	1.9	1.9	1.9		0
3	12	1987-2002	1.9	540	5	2	40	8
4	16	1987-2002	1.9	23	6	5	17	0
5	17	1987-2002	1.9	70	7	5	32	6
6	17	1987-2002	1.9	49	8	8	33	6
7	17	1987-2002	1.9	130	7	8	37	12
8	7	1987-1987	2	240	19	14		29
9	17	1987-2002	1.9	130	11	13	71	24
11	12	1987-2002	1.9	130	10	7	97	25
A11	10	1999-2002	2	240	27	52	218	50
12	6	1987-1987	1.9	350	18	22		33
13	7	1987-1987	13	1,700	161	130		86
A13	6	1987-1987	1.9	920	51	105		67
14	6	1987-1987	33	1,600	373	445		83
16	16	1987-2002	1.9	23	3	2	9	0
17	11	1987-2002	1.9	33	6	5	26	0
18	12	1987-2002	1.9	70	3	1.9	11	8
19	7	1987-1987	1.9	33	4	1.9		0

Note: The following values have been shaded:
Geometric Mean > 14 Median > 14
90th Percentile> 43 (% > 43) > 10
1.9 represents <2 MPN/100mL 1,700 represents >1,700 MPN/100mL

Excessive fecal coliform concentrations, with respect to shellfish harvesting, were recorded in Eel River, the impoundment and within the shallow waters of the Eel River estuary, downstream of the dam (stations 9, 11 and A11 in Table 3.15.1). Richard and Godin (2003) suggested that the elevated fecal coliforms at station A11 were potentially attributable to the large number of waterfowl observed at this site and to possible elevated bacterial densities from upriver of the dam.

Whereas elevated fecal coliform concentrations were recorded in 1987 at a few sampling stations along the coastline of Eel Bay, water quality was found to be satisfactory at most stations during the 1999 and 2002 sampling seasons (stations 2 to 5, 16 to 19; Table 3.15.1). The mouth of the Restigouche River lies immediately north of Eel Bay. Therefore, in addition to concerns over local contamination sources, there is also the potential for contaminated water from the Restigouche River to negatively impact the Eel Bay coastal waters during periods of high runoff from land.

Coliform/*E. coli* sampling was also conducted for this EIA study in 2004 and 2005. Table 3.15.2 shows the bacterial counts obtained during spring runoff in 2004 in the Assessment Area immediately upstream of the Eel River dam and in Eel Bay for comparative purposes. The locations of these sampling stations are shown in Figure 3.4.2. At the time of water sampling, one gate in the control structure of the dam was open and water was overtopping the other 5 closed gates because of the higher water level in the impoundment during the spring runoff conditions. Therefore the concentration of coliforms in the impoundment water may provide an indication of the contribution of coliforms in this freshwater source during high spring runoff conditions to the estuary of Eel River and further out into

Eel Bay. It can be seen in Table 3.15.2 that the concentration of *E. coli* is five times higher for the impoundment water compared to that of the marine water in Eel Bay. Further, the concentration of bacteria in the impoundment is not quite as high as that measured in other studies at the outfall location of the sewage lagoon in the Village of Eel River Crossing when it was in operation before June 2005. This can also be attributed to the dilution effect of high river flow in Eel River during spring runoff conditions.

Table 3.15.2 Bacteriological Analyses of Water Samples from the Eel River Area in 2004.

Station	U1 (upstream of dam)	U7 (Eel Bay)
Sampling Date	May 6	May 6
Total Coliforms/100mL	752	105
E. coli/100mL	40	8
Tide	Rising	Rising
Rain (mm)		
0-24 hr	0.6	0.6
0-48 hr	0.6	0.6
0-72 hr	4.6	4.6

A greater sampling effort in this EIA study for bacteria, including the taking of field replicates and blank water samples as controls, was placed upstream of the dam and close to the control structure in the summer 2005 after the WWTP of the Village of Eel River Crossing was decommissioned in June 2005. The objective was to assess potential improvements in the concentration of coliforms in the impoundment water and when coliform survival would be at its highest because of the warmer water temperatures in the summer and little or no flow through the control structure of the dam for potential dilution. These coliforms could be a possible source contributing downstream to the estuary and shellfish beds if the dam is removed. The coliform results for 2005 are provided in Table 3.15.3. This table shows that the concentration of coliforms in the impoundment has been reduced considerably and generally less than 10 *E. coli* /100 mL, and well within the CCME guidelines for recreational water standards of 200/100 mL (CCME, 1998). The results for September are slightly higher than for other sampling events, but still within CCME standards, because of the higher rainfall within the previous 48 hours and most likely subsequent runoff into Eel River upstream of the dam.

Table 3.15.3 Bacteriological Analyses of Water Samples for Station TD1 (U1) in 2005.

Sampling Date	July 21			August 18			September 21		
Sample ID	Sample 1	Sample 2	Distilled Water	Sample 1	Sample 2	Distilled Water	Sample 1	Sample 2	Distilled Water
Total Coliforms/ 100mL	0	0	0	100	8	0	30	44	0
Fecal Coliforms (MPN/100mL)	0	0	0	0	8	0	27	18	0
E. coli/100mL	0	0	0	0	2	0	7	9	0
Tide	Lowering	Lowering	Lowering	Lowering	Lowering	Lowering	Lowering	Lowering	Lowering
Rain (mm)									
0-24 hr	0.7	0.7	0.7	0	0	0	15.8	15.8	15.8
0-48 hr	0.7	0.7	0.7	0	0	0	15.2	15.2	15.2
0-72 hr	1.4	1.4	1.4	6.6	6.6	6.6	0.6	0.6	0.6

Environment Canada re-evaluated in 2005 the bacteriological water quality for the classification of shellfish growing areas in the Eel River-Charlo area, which is normally conducted every 3 years (Godin, pers. comm.). The last time this routine re-evaluation was carried out was in 2002 (see above). The report for the 2005 re-evaluation will be completed sometime in 2006. However, preliminary information on the results was provided by Environment Canada (Godin, pers. comm.) and is discussed below.

The tendency of fecal coliform concentrations in receiving waters for most regions of New Brunswick is to increase towards the end of June and decrease in the fall, mostly as a result of human activity. This tendency is also noted for Eel River. In addition, many shellfish growing areas show increased fecal contamination levels as a result of accelerated runoff from land following significant rainfall events (Richard and Godin, 2003). According to Environment Canada, daily rainfall conditions should therefore be considered when interpreting bacteriological data. Areas sensitive to runoff pollution are typically negatively affected by rainfall accumulations of 12.5 mm within 24 hours and/or 25 mm within 48 hours prior to sampling. Less sensitive areas may only be affected following 25 mm, 38 mm and/or 55 mm within 24 hr, 48 hr and 72 hr, respectively. It rained every time that Environment Canada sampled in the Eel River-Charlo area in the summer 2005: 8 mm on June 6; 0.6 mm on June 30 (negligible); 13.7 mm on July 14; 5.3 mm on August 1; and 3.4 mm on August 10. The sampling event that overall contained the least fecal coliform concentrations for the area was that of June 6, 2005.

Deterioration in the quality of water with respect to fecal coliforms was noted by Environment Canada just upstream of the tidal inlet in the estuary (station 6) and immediately downstream of the dam (station A11) compared to previous years (Figure 3.15.1). The concentration of fecal coliforms at these stations increased sharply in 2005. On June 6, station 6 was noted to have the highest coliform concentration and station A11 the lowest for the year (coliform concentration at station A11 increased substantially after this date). The concentration of coliforms at stations 7 and 9 along the Eel River bar in the estuary was similar to results from previous years. Station 18 at the Charlo Beach in Eel Bay had good water quality in 2005, with fecal coliform concentrations well below CCME guidelines for recreational waters, but not for shellfish harvesting. Fecal coliform results, based on 5 sampling events, at station 5 in the channel of the tidal inlet, surpassed the norm in 2005, which never occurred in the past. Station 2, located to the south of the sewage lagoon outfall of the Town of Dalhousie in Eel Bay, did not change from previous years with respect to the concentration of fecal coliforms.

It should be noted that the 2005 fecal coliform survey undertaken by Environment Canada was carried out before and after the WWTP of the Village of Eel River Crossing was decommissioned in June 2005. Therefore the higher concentration of fecal coliforms in the estuary after June 2005, and as measured by Environment Canada, cannot be attributed to the WWTP or water from the impoundment flowing into the Eel River estuary. Similarly, water from Eel Bay contained less fecal coliforms than in the estuary. It is suggested that the higher concentration of fecal coliforms in the estuary in July and August 2005 may be attributable to the waterfowl in the estuary (Godin, pers. comm.), as suggested in 2002 (Bernard and Godin, 2003). The high concentration of fecal coliforms upstream of the tidal inlet in June 2005 may also be attributable to migrating birds during this period. The Jacques Whitford Study Team has noticed large gatherings of waterfowl perched on the exposed sand and gravel deposits downstream of the dam and upstream of the tidal inlet at low tide in the estuary during both the 2004 and 2005 ice-free sampling seasons.

In summary, the existing potential risks to Public Health and Safety from bacteria are low in the upper reaches of Eel River and upstream of any villages and municipalities. Non-point (*e.g.*, runoff from land) and point sources (*e.g.*, culverts, overflow of Balmoral sewage lagoon) of fecal pollution are higher in villages adjacent to the Eel River such as Dundee (Unincorporated), Eel River Crossing and Balmoral. Decommissioning of the Village of Eel River Crossing WWTP and of the effluent outfall into Eel River improved substantially the level of fecal coliforms in the impoundment and eliminated this source of pollution to the downstream environment in the Eel River estuary and Eel Bay. However, the concentration of fecal coliforms did not improve in the estuary and which can still affect the shellfish beds that are found there, including those beyond in Eel Bay. The most likely source of fecal pollution in the estuary is being attributed to the large gathering of waterfowl that include migratory birds and shorebirds.

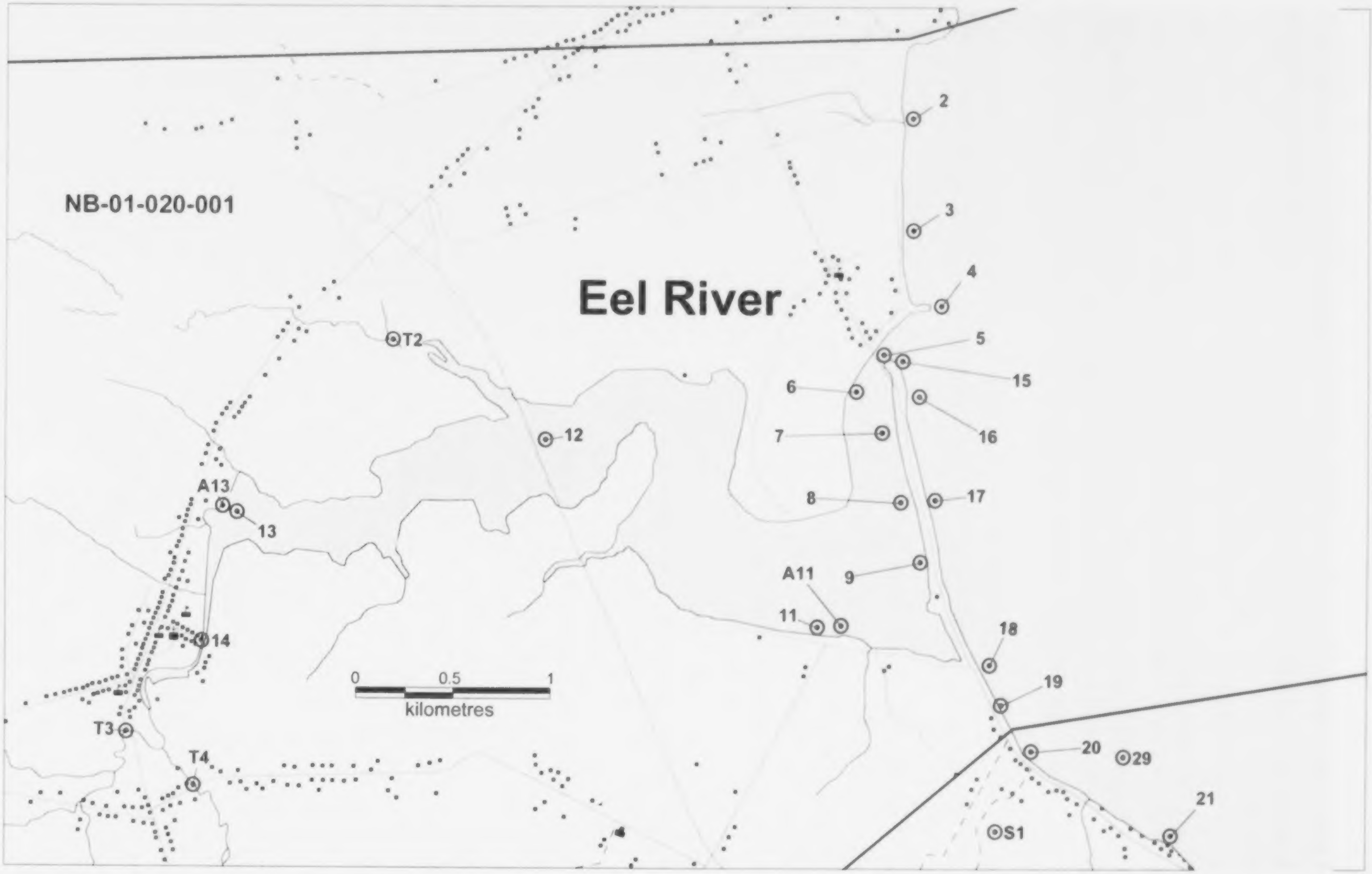
3.15.3 Food Resource Contamination

3.15.3.1 Pre-dam Conditions

There are no available data on contamination of fish, shellfish (softshell clams) or harvested plants in the Eel River area prior to the construction of the dam. The Eel River, estuary and Eel Bay provided a commercial and recreational fishery during the historic period, and fish and shellfish were an important food source for Aboriginal people prior to the arrival of European settlers. The Eel River was productive and supported many migratory species including but not limited to Atlantic salmon, rainbow smelt, American eels, brook trout, gaspereau, Atlantic tomcod and American shad. Although no data were available on the harvesting or level of contamination of plants in the Assessment Area, recreational plant harvesting of blueberries and sweet grass were very common in the Eel River area (see Section 3.11 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons for further information).

3.15.3.2 Post-dam and Existing Conditions

In the post-dam construction period, the river experienced many alterations and consequently has been unable to support the species richness characteristic of pre-dam conditions. The fishway at the dam did not allow species including smelts, gaspereau and shad to pass. Atlantic tomcod also suffered, although currently there is a subsistence/recreational fishery in the Eel River estuary below the dam. Atlantic salmon are able to navigate the fishway though with great difficulty. Throughout the post-dam period, the majority of migratory fish stocks declined with a result of no returns in many cases.


NB-01-020-001
Eel River
2
3
4
5
15
6
16
7
12
T2
A13
13
8
17
A11
9
11
18
14
19
0
0.5
1
kilometres
T3
T4
20
29
21
S1

Environment Canada Fecal Coliform Sampling Station Locations in the Eel River Area (taken from Bernard and Godin, 2003)

Date: 03/31/2006	Scale:
Job No. 15830	Figure No. 3.15.1

Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT

NBDSS PROJECT No. YR101A

Clam digging and harvesting in shellfish beds located in the estuary and along the Eel River bar in the bay were officially closed for recreational and commercial purposes for the first time in 1972 by DFO after excessive coliform counts were measured (MacNair, pers. comm.). After this fishery was re-opened, harvesting of shellfish was banned once more by DFO on October 30, 1988 because the water was again contaminated by coliform bacteria (Albert, pers. comm.). This area, including the Restigouche River and the majority of Chaleur Bay inside a line intersecting the New Brunswick/Quebec provincial boundaries, is currently closed to shellfish harvesting for direct consumption. After the last re-evaluation report in 2003 by Environment Canada for the Eel River estuary and bay shellfish growing area (Richard and Godin, 2003), it was recommended that there was no major change in sanitary conditions within the survey area and the current classification status of closed shellfish area should remain unchanged. However, shellfish harvesting for depuration purposes could be allowed along the outer Eel River bar and within the Eel River estuary.

While some plant harvesting for sweet grass still occurs in the Eel River estuary, it has been completely eliminated in the impoundment area. The decline has been attributed to the construction of the dam.

The level of contaminants in existing fish and softshell clams (*Mya* species) in the Eel River area was raised as an issue for concern in meetings with the Aboriginal Community, stakeholders and the public, including at the open houses held for this EIA study. To address this issue, the Jacques Whitford Study Team collected resident adult fish (yellow perch) upstream of the dam and softshell clams upstream of the tidal inlet in the estuary to assess for potential bioaccumulating contaminants. Migrating fish species such as salmon were not selected because any contaminants found in this species could not be attributed with certainty as originating in the Eel River watershed. Therefore non-migrating, yellow perch trapped in September 2005 with gill nets placed approximately 400 m downstream of the outfall to the Village of Eel River Crossing sewage lagoon were analyzed for bioaccumulating contaminants (heavy metals, including mercury, and PCBs). Only the meat fillet from the fish was analyzed for contaminants. Three separate analyses were conducted and based on different fish to obtain a good representation of the adult fish population. Similarly, only the meat from legal-sized softshell clams (*i.e.*, > 51 mm) collected at three locations in the lower reaches of the estuary were analyzed for contaminants. The clams were depurated in clean seawater for 24 hrs (to rid of potential sediments that could bias the results) prior to being analyzed for metals and PCBs. Three separate clam samples and analyses were carried out, with each sample comprised of approximately 10 clams from one location to achieve the necessary quantity for analysis. All tissue analyses were conducted by the Research Productivity Council (RPC) Laboratory in Fredericton.

The analytical results on the fish and clams tested are presented in Table 3.15.4. All three fish samples are below Canadian Food Inspection Agency and Health Canada guidelines ("Maximum Limits") available for mercury, arsenic, lead and PCB in fish and fish products. The clams tested are also all below guideline limits set by the Canadian Food Inspection Agency and Health Canada for metals and PCB. This suggests that, other than the possibility of fecal coliform contamination of clams because of the poor bacteriological water quality in the estuary (refer to Section 3.15.2 above), the fish and clams in the Assessment Area are generally not contaminated with metals and PCBs. The fish and clams in the Eel River area may be fit for human consumption if Health Canada guidelines for eating fish and shellfish are followed and if the clams are harvested for depuration purposes as recommended by Environment Canada. However, only DFO, in consultation with the Canadian Food Inspection Agency and Environment Canada, can remove a ban on shellfish harvesting.

Table 3.15.4 Results of Tissue Analysis in Fish and Softshell Clams from the Eel River Area in 2005.

Analyte	Health Canada and Canadian Food Inspection Agency Maximum Guideline Limit*	Detection Limit	Adult Fish (yellow perch) in Eel River				Legal-sized Softshell Clam (> 51 mm) in the Eel River Estuary			
Metals			Sample 1 & 4	Laboratory Duplicate	Sample 2 & 5	Sample 3 & 6	Sample 1	Laboratory Duplicate	Sample 2	Sample 3
Concentration (mg/kg)					Concentration (mg/kg)					
Aluminum		< 0.02	0.92	0.58	1.63	0.58	37.4	35.9	72.4	67.3
Antimony		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Arsenic	3.5	< 0.02	0.03	0.03	0.04	0.02	0.39	0.36	0.40	0.51
Barium		< 0.02	< 0.02	< 0.02	0.03	< 0.02	0.36	0.36	0.57	0.68
Beryllium		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.003	0.003
Bismuth		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Boron		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	1.80	1.70	1.90	2.31
Cadmium		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.033	0.032	0.031	0.038
Calcium		< 1	189	163	222	275	364	355	548	495
Chromium		< 0.02	0.05	0.05	0.06	0.05	0.16	0.15	0.34	0.29
Cobalt		< 0.002	0.002	0.002	0.003	0.003	0.137	0.136	0.166	0.144
Copper		< 0.02	0.27	0.20	0.22	0.23	1.04	1.01	1.00	1.18
Iron		< 0.5	3.0	3.3	3.8	2.4	57.2	52.2	137	134
Lead	0.5	< 0.002	0.011	0.009	0.014	0.006	0.072	0.060	0.162	0.166
Lithium		< 0.002	< 0.002	< 0.002	0.003	< 0.002	0.117	0.115	0.160	0.182
Magnesium		< 0.2	294	294	291	296	646	624	678	800
Manganese		< 0.02	0.18	0.16	0.25	0.15	1.82	1.31	12.1	31.8
Mercury	0.5	< 0.01	0.39	0.41	0.22	0.31	0.01	0.01	0.02	0.01
Molybdenum		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.130	0.120	0.130	0.120
Nickel		< 0.02	0.02	< 0.02	0.04	< 0.02	0.18	0.16	0.25	0.31
Potassium		< 0.4	3590	3690	3560	3560	973	955	1020	1140
Rubidium		< 0.002	2.47	2.54	2.53	2.43	0.417	0.414	0.475	0.526
Selenium		< 0.02	0.11	0.11	0.13	0.10	0.18	0.22	0.22	0.24
Silver		< 0.002	0.002	< 0.002	< 0.002	< 0.002	0.020	0.018	0.023	0.027
Sodium		< 1	471	481	478	479	4470	4300	4700	5430
Strontium		< 0.02	0.10	0.08	0.15	0.16	5.40	5.30	8.26	8.52
Tellurium		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Thallium		< 0.002	0.002	0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Tin		< 0.002	0.013	0.010	0.014	0.016	0.016	0.014	0.013	0.019
Uranium		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.014	0.013	0.014	0.013
Vanadium		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.13	0.12	0.24	0.27
Zinc		< 0.02	6.20	6.30	6.59	6.57	9.15	8.85	10.8	10.6
Total PCB	**2.0**	< 0.1	<0.1		<0.1	<0.1	<0.1		<0.1	<0.1

*Enforced under *Canadian Food and Drugs Act*, 1991

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

4.0 EVALUATION OF EXISTING FISHWAY AND POTENTIAL IMPROVEMENTS TO THE FISHWAY AGAINST THE FISH PASSAGE PROJECT OBJECTIVE

The EIA Guidelines established that the Project Objectives are to achieve "*a long-term solution to fish passage and other ecosystem issues*". For the purpose of this EIA, the specific fish passage Project Objective was therefore defined in consultation with the TRC as the "*unimpeded and safe movement, upstream or downstream, of fish between aquatic habitats required to complete their life cycle*". The other Project Objectives identified were to establish "*conditions that lead to the natural re-establishment of saltmarsh wetlands upstream of the current dam, and improvement of habitat for softshelled clams and other shellfish upstream and downstream of the Eel River dam.*"

This chapter provides an evaluation of the existing fish passage conditions and an evaluation of the available alternatives (*i.e.*, replacement of the fishway and other modifications to the existing structure or maintaining the current conditions into the future (the Status Quo)) for achieving the Project Objectives. Only one potential alternative to dam removal identified was modifications to the existing fishway. The Status Quo is not an alternative, but is carried forward for comparative purposes only. This chapter discusses the viability of the identified alternative to achieve the fish passage and other Project Objectives.

4.1 Fish Passage Project Objective

4.1.1 Requirements of Fish Species for Passage

The fish species requiring passage at the dam were initially identified through discussions with the regulatory agencies, consultation with the public and stakeholders, and meetings with the Aboriginal Community. Field investigations described in Section 3.4.3 did not confirm the presence of all species, however, for the purpose of the EIA, the species requiring migration past the dam for life cycle purposes were determined in consultation with the TRC to be:

- American eel (*Anguilla rostrata*);
- rainbow smelt (*Osmerus mordax*);
- American shad (*Alosa sapidissima*);
- gaspereau (blueback herring + alewife) (*Alosa aestivalis* + *Alosa pseudoharengus*);
- sea lamprey (*Petromyzon marinus*);
- Atlantic salmon (*Salmo salar*);
- brook trout (*Salvelinus fontinalis*); and
- Atlantic tomcod (*Microgadus tomcod*)

The species listed above were selected since they require access to upstream portions of the Eel River watershed, or formerly brackish habitat now occupied by the impoundment, to complete their life cycle. Therefore they require effective fish passage at the dam. The biology of these species has evolved so that they can take advantage of different habitat types in order to complete their life cycle. These fish species are termed anadromous and catadromous. Anadromous fish are those that spawn (produce or deposit eggs) in freshwater but feed and grow predominantly in saltwater. Catadromous species spawn in saltwater but feed and grow predominantly in freshwater. All of the species listed above are anadromous except for the American eel, which is catadromous.

A unique feature of these species is that at various stages of their life cycle they can tolerate living in the freshwater or saltwater environments. When these fish undergo the physiological changes necessary to permit survival in their new environment and are ready to migrate between the freshwater and saltwater environments, they have a very narrow window in time during which they can tolerate the movement from one to the other. Therefore, it is critical that the windows for migration be synchronized with migratory behaviours in order to ensure their survival. For example, Atlantic salmon smoltify (become physiologically capable of living in full-strength saltwater and are referred to as "smolts") at about 10 °C in rivers when they are ready to migrate to saltwater. This occurs when they are approximately 15 cm in length (2 or 3 years old). Their physiological capability to tolerate saltwater is of limited duration after which the smolts will not be able to survive in saltwater.

Fish migration is governed by several factors including time of day, length of day, season of the year, freshwater signal, water quality, water temperature, water velocity (speed at which water flows downstream), flow direction, tide levels and the location of fish in the water column. Synchronization between these factors is very important for successful fish migration. Such synchronization, in the Eel River system, is complicated by the wide variety of migratory requirements associated with the fish species requiring migration at the dam. The migratory behaviour of these fish species vary greatly in relation to their spawning age, their migration patterns during the day and their time of spawning. Species requiring upstream migration at the dam move at different times during the day and spawn during most months of the year.

The swimming ability of these fish species and, therefore, their speed of travel and their ability to withstand currents can be directly related to their size (large fish are stronger swimmers). Due to the large range in the sizes of the species requiring migration at the dam, considerable difference between their swimming abilities is evident. Such a large difference in swimming abilities complicates the design of an appropriate fish passage facility. The swimming abilities of the identified fish species are shown in Table 4.1.1. Sustained speed is defined as the speed that the fish can maintain almost indefinitely; while burst speed is defined as the speed that can be maintained for 5 to 10 seconds, to capture prey, escape predators, or leap falls.

In summary, the fish species requiring migration at the dam use both freshwater and saltwater, they travel up and down rivers, and they have different characteristics and needs. The varying characteristics and migratory behaviour of these fish species adds to the complexity of designing a fish passage facility to accommodate the needs of the species requiring migration at the dam. It is important that all of the factors governing fish migration be synchronized for the successful survival of these species.

Table 4.1.1 Swimming Abilities of Fish Species that Require Fish Passage

Fish Species	Sustained Speed m/s		Burst Speed m/s	
	Adult	Juvenile	Adult	Juvenile
American eel	1.5	0.15	6.0	0.6
Rainbow smelt	0.30		1.00	
American shad	1.5	0.2	6.0	0.8
gaspereau	0.6	0.15	2.5	0.6
sea lamprey	2.0	0.25	3.5	1.0
Atlantic salmon	1.4	0.4	7.5	1.5
brook trout	0.75		3.0	
Atlantic tomcod	0.35		1.25	

Sources: Katopodis, 1992; Alexander, 1974.

4.1.2 Description of Existing Fishway

When the Eel River dam was constructed in 1963, it was equipped with a fishway to provide upstream passage for diadromous fish. Some species may also be able to access Eel River over the spillway (part of a control structure designed to allow water to spill over a dam without weakening it) and gates of the dam. In addition to the fishway, there are also six openings in the control structure of the dam, each 3.6 m wide. Three of the openings closest to the fishway are equipped with stoplogs (box, logs or planks with a drainpipe at the bottom that extends through the wall of an impoundment) overlying a steel gate. The top of the gate closest to the fishway is also equipped with a trapezoidal weir (v-notch stoplog), installed a few years ago under the guidance of DFO, to enhance fish passage (Figure 4.1.1). The other three openings to the north (farthest from the fishway) contain only a steel gate in the spillway. All six gates in the spillway can control impoundment water levels and discharge rates. However, only the three steel gates farthest from the fishway are generally used to control downstream water flow through the dam (Guitard, pers. comm.).

The Town of Dalhousie operates the Eel River dam fishway. However, DFO monitors fishway operation and notifies the Town if there is a problem with the fishway. There is no Gate Management Plan in place and the Town usually follows DFO instructions. In the spring the steel gates are opened primarily to control flooding upstream at Eel River Crossing, but also to permit upstream fish passage. During this season, generally one steel gate is opened fully with a second steel gate opened to the halfway position. No gates remain open in winter, and in the summer the gates are usually closed except during periods of heavy rainfall. Further, in the summer there is no flow through the dam except through the fishway. The gates are opened to control flooding, not to allow fish passage. Grating is installed over the fishway to eliminate poaching of fish (Guitard, pers. comm.).

The crest elevations of the spillways range from 1.783 to 2.085 m. Gate 1 has a V-notch to an elevation of 1.535 m.

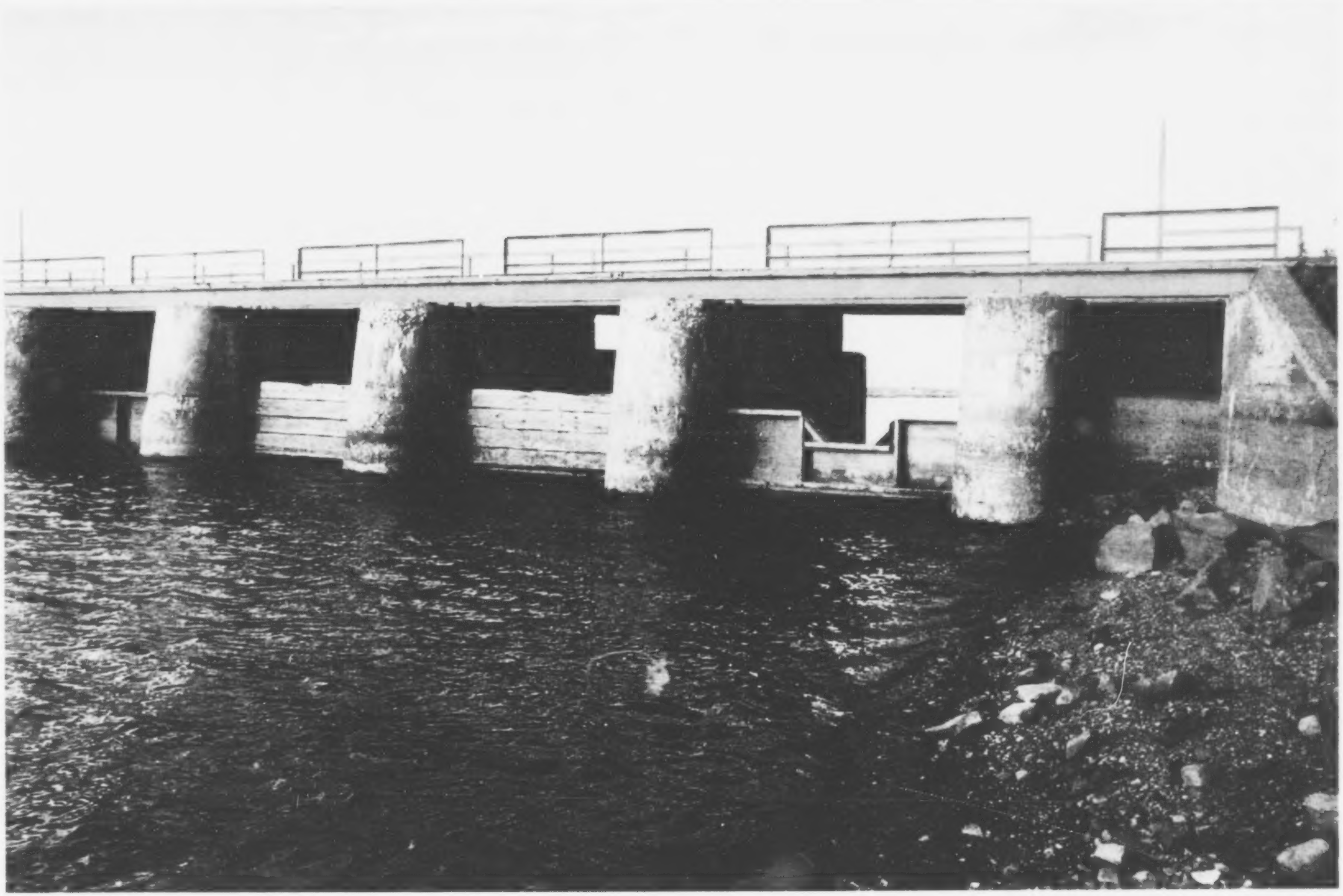
The actual (as opposed to predicted) tide level in the estuary below the dam is occasionally in excess of these levels in the spring and the fall (Kingston, pers. comm.). Storm surges have historically brought the tide level to greater than 2.3 m (McCarthy, 1963). Spring and fall are the principal seasons of upstream migration by diadromous fish. Therefore, the impoundment is maintained at a level as close to the predicted high tide level as practical and is always maintained between the elevation of the crest of the spillway, approximately 1.98 m and 4.24 m (the maximum impoundment height) (various correspondence including letter, Mr. L.W. McCarthy, Soils Engineer to Dr. John Bates, Chair, NB Water Authority, 1963). At or near high tide, jumping fish such as Atlantic salmon and brook trout can gain upstream access into the impoundment through the spillway stoplog openings, principally through the V-notch stoplog, which has an elevation of 1.53 m. In 2002, 50 to 100 Atlantic salmon were observed waiting at the bottom of the gates for high tide when they could jump over the V-notch in the gate closest to the fishway (Guitard, pers. comm.). At certain times a 2-foot deep stoplog is also removed from the gates to promote fish passage (Guitard, pers. comm.). During unusually high tides, which create low head differences across the dam, even weak swimming and non-jumping fish have been occasionally observed to move upstream into Eel River, particularly in the spring (Guitard, pers. comm.).

The fishway (Figure 4.1.2) is a combination pool and weir and pool and orifice type. It has three pools that are defined by four baffles (weirs). Each pool is approximately 0.91 m deep. There is a 30 cm drop between each of the bottom three weirs, which have elevations of 0.76, 1.07 and 1.37 m, respectively. All of the weirs are 1.83 m wide, and the bottom three weirs each have a 76 cm long, 23 cm deep notch in the centre. The flow between pools is concentrated in these notches. Each of the bottom three weirs also has a 7.6 x 7.6 cm drain clean-out orifice that is situated at the bottom of the weir, where it meets the floor of the pool. The weir at the fishway exit (upstream end) has a top elevation of 2.44 m. Fish passage is provided through a 33 cm opening in the weir that has an invert elevation of 0.76-m (*i.e.*, 30 cm above the floor of upstream pool #3).

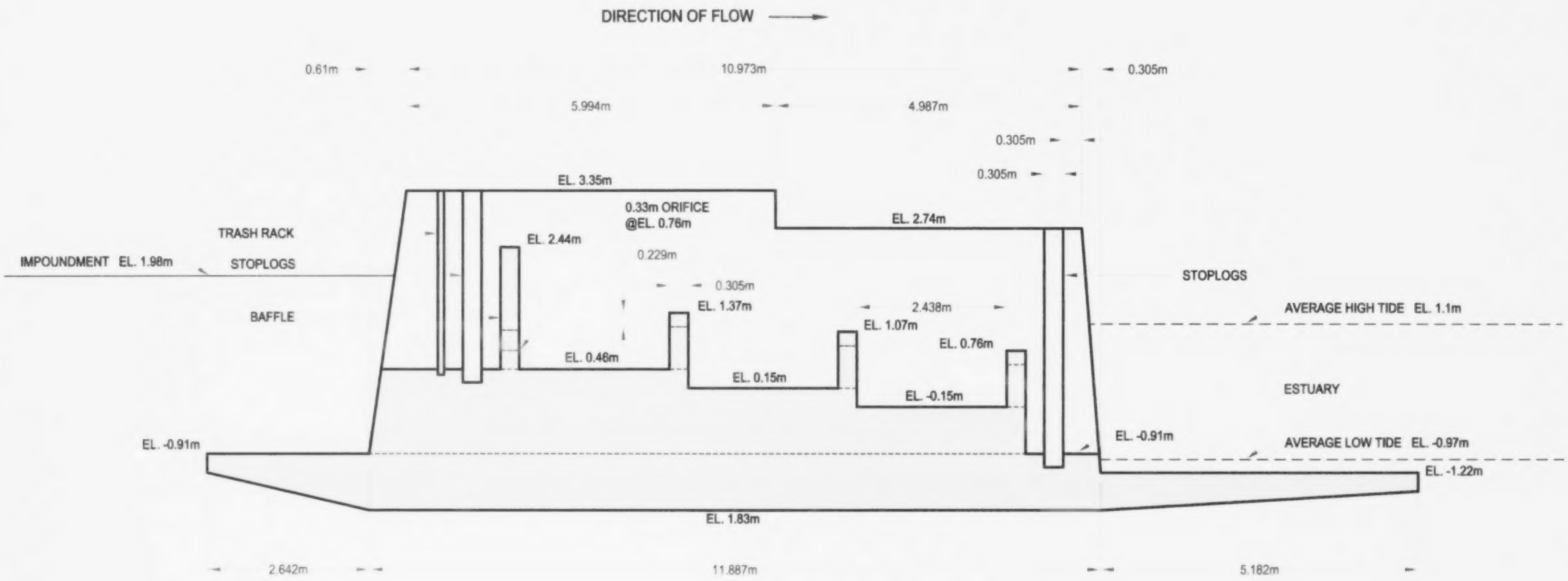
4.1.3 Effectiveness of Existing Fishway

This section describes the current effectiveness of the fishway for each fish species known to require migration past the Eel River dam for life cycle purposes.

Glass eels (*i.e.*, young American eels that are in their transparent larval stage) arrive in the estuaries of north temperate rivers in May and June. They transform into small eels (also known as elvers), and begin their upstream migration to foraging grounds in freshwater. Near the estuary, elvers have little difficulty gaining access past freshwater barriers as they can move up vertical faces as long as they are damp (Balon, pers. comm.). High water velocities through the submerged opening in the upstream exit, baffle #4, may prevent access by elvers via this route, however the dam would provide no upstream passage difficulty for adult American eels.



Eel River Dam Control Structure and Fishway Photo	Date: 03/31/2006	Scale:	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **4.1.1**	NBDSS PROJECT No. YR101A


DIRECTION OF FLOW
0.61m
10.973m
0.305m
5.994m
4.987m
0.305m
0.305m
EL. 3.35m
0.33m ORIFICE
@EL. 0.76m
EL. 2.74m
TRASH RACK
EL. 2.44m
IMPOUNDMENT EL. 1.98m
STOPLOGS
0.229m
STOPLOGS
0.305m
EL. 1.37m
2.438m
AVERAGE HIGH TIDE EL. 1.1m
BAFFLE
EL. 1.07m
EL. 0.76m
EL. 0.46m
EL. 0.15m
ESTUARY
EL. -0.15m
EL. -0.91m
EL. -0.91m
AVERAGE LOW TIDE EL. -0.97m
EL. -1.22m
EL. 1.83m
2.642m
11.887m
5.182m

FISHWAY SECTION

FILE: 15830\EIA REPORT\DAM REMOVAL

NOTE:

FISHWAY SECTION

Date: 2006 03 31

Scale: N.T.S.

Job No.: 15830

Fig. No.: 4.1.2

Eel River Dam Environmental Impact Assessment

NBDSS PROJECT No. YR101A

Rainbow smelt enter Maritime rivers at night in April and May. They are small-bodied fish and are not particularly strong swimmers. The one-foot drop over the bottom three baffles of the fishway would produce plunging flows, and likely prevent smelt from gaining access to pool #3 (the exit pool) at low tide levels. On many rising tides coupled with spring freshet river discharges that decrease the head difference between the impoundment and the estuary, smelt probably are able to travel though the clean-out drains or over the drowned out baffles and gain access to the exit pool. Whether they are able to make it into the impoundment depends on the water velocity through the 33 cm diameter opening in baffle #4.

In mid Spring, the impoundment is maintained at a low level, and one or more gates are left open, primarily to prevent upstream flooding, but also to facilitate upstream passage. Conceivably the impoundment level, even in freshet conditions that would predominate at the time of smelt run could be lowered to 2.0 m. The flood freshet would also raise the estuary to a level greater than the maximum tide elevation of approximately 1.6 m. If the elevation of the estuary achieved a level of 1.7 m during nighttime (the preferred migration time for smelt), there would be a head difference of 30 cm between the lagoon and the impoundment. In this case, smelt would have to swim against a 2.4 m/s water velocity in the submerged orifice in the exit weir of the fishway to gain access to the impoundment. Using a rule-of-thumb that burst swimming-speeds of teleost (bony, not eel-like) fish are ten times their body length per second (Alexander, 1974), a large 25 cm smelt could theoretically swim 2.5 m/s. Since the baffle wall is only 30 cm thick, smelt would be able to move through the opening and into the impoundment. Under this scenario, smelt may also be able to gain access to the impoundment through the gate openings.

To summarize, smelt would be able to gain access to the impoundment if the Eel River estuary achieves an elevation of 1.7 m or greater at night during the smelt spawning window. Near equivalent water elevations between the impoundment and the estuary are occasionally achieved in the Spring, particularly when there is an east wind blowing (Guitard, pers. comm.). However, these conditions are by no means certain, and it is concluded that smelt access from the Chaleur Bay into the Eel River is seriously impaired.

American shad that would normally move into the Eel River to spawn in May and June will not use the type of fishway currently operating on Eel River. Shad will not jump (Larnier and Travade, 2002), and at low tide, the wide notches in the lower three baffles probably produce plunging flows that require fish to jump. On rising tides when the lower baffles are drowned out, and the flows are less turbulent, shad could conceivably gain access to the exit pool. However, shad will not swim through submerged openings (Larnier and Travade, 2002), which effectively denies them access to Eel River through the fishway. Shad enter the river to spawn approximately one month after the smelt run. Therefore, unlike smelt, they cannot take advantage of the normal spring gate openings, and not have the advantage of freshet-increased water levels in the estuary.

The fishway is not ideal for gaspereau, also referred to as blueback herring and alewife, as these species also spawn in May and June. Like shad, gaspereau prefer to have streaming flow over baffles (Hubley, pers. comm.), a situation that results from high water velocities or shallow flow trajectories.

The wide notches in the lower three weirs make the formation of streaming flow improbable in the existing fishway. Gaspereau would be able to gain upstream access to Eel River on rising tides when the bottom pools are effectively drowned out. They are strong swimmers with maximum burst swimming speeds of 3 m per second or greater based on their body length of approximately 30 cm. Gaspereau will travel through submerged openings, which make Eel River accessible at head differences between the impoundment and the estuary of up to 61 cm (*i.e.*, an impoundment level of 1.98 m and a tide level of 1.37 m). The water velocity through the submerged orifice at 61 cm of head is 3.5 m/s. However, since the majority of gaspereau only migrate during daylight, the effectively drowned-out pools at night would be useless, reducing the probability of fish passage. Therefore, the fishway is only effective for passing gaspereau for years where the high tide occurs during the day which was not the case in 2005.

Sea lampreys are strong persistent anguilliform (eel-like) swimmers and have been known to use their suction cup like mouths and tails to move past seemingly impassable barriers. This species would be able to gain access to the impoundment over the spillways or through the fishway.

The fishway was built primarily for Atlantic salmon. The plunging flow into the bottom two pools and over the entrance weir is ideal for upstream salmon passage (Clay, 1995). Large, strong fish like salmon would easily overcome the velocities through the exit opening. The presence of clouds of filamentous algae in the fishway late in the summer and in the early autumn has been known to discourage salmon from using the facility (Madden, pers. comm.). The recent connection of the Eel River Crossing sewage system to the treatment system of the Town of Dalhousie should theoretically lower nutrient input and mitigate the algal barricade problems. However comparison of TP concentrations before and after the establishment of the connection revealed no significant difference (Section 3.4.1.2).

Similar to Atlantic salmon, large brook trout would have no problem using the existing fishway to gain upstream access to Eel River, although algae may present a physical and psychological barrier to these fish as well.

The Atlantic tomcod is a small bodied, weak swimming fish. It spawns in the winter (Liem and Scott, 1966), when impoundment water levels are presumably maintained at a high level. It is unlikely that tomcod can gain upstream access into Eel River through the fishway or the spillways.

4.1.4 Potential Fishway Improvements to Promote Improved Fish Passage

4.1.4.1 Performance Issues

The major drawback with the current Eel River dam fishway configuration for the passage of the target species is at the exit weir. The minimum head difference across this weir when the pools are drowned out by the tide, and with no storm surges, is still greater than 30 cm. This creates a velocity through the orifice that cannot be overcome by small-bodied fish such as rainbow smelt and Atlantic tomcod. The flow velocity through a submerged orifice for a 30 cm drop is 2.4 m/s, greater than the maximum exit velocity of 2.0 m/s that is recommended by fish passage experts (FAO and DVWK, 2002). In addition, shad will not swim through submerged orifices. Another problem with the fishway is that drops of 30 cm between the inlet and the intermediate pools, and the intermediate and the exit pool, are greater than recommended for shad (Quinn, 1994). A 30 cm drop is undoubtedly too great for rainbow smelt and tomcod as well; however these species are very difficult if not impossible (US Water News, 1997) to accommodate in a fishway system. Therefore, a key objective of any improvement to the existing fishway, should be the ability to allow shad to effectively pass upstream. Such improvements would also likely allow salmon and trout to effectively pass. Attempts can be made to modify the structure to also pass smelt, however tomcod passage would undoubtedly remain limited regardless of what improvements are made to the fishway structure.

4.1.4.2 Potential Improvements to Fishway

To improve fish passage, there are a number of potential improvements that could be made to the existing fishway. These potential improvements are described below.

4.1.4.2.1 Lower the Drop Between the Lower Pools

It is recommended that a maximum drop of 20 cm be used in any fishway that is intended to allow shad passage (Quinn, 1994). Accomplishing this would involve lowering the second and third weirs of the fishway to elevations of 0.66 m, and 0.86 m, respectively, while maintaining the 23 cm deep slot. The top weir would have to be lowered to 1.06 m.

4.1.4.2.2 Deepen the Existing Pools

The bottom elevations of Pools 1 through 3 are at elevations respectively of -0.15 m, +0.15 m, and 0.46 m, which provide pool depths of 0.91 m. After modification of the baffles the pool depths would be 0.91 m, 0.81 m, and 0.70 m, respectively. The pools would have to be deepened to provide a constant depth of 1.22 m. Therefore, the bottom elevation of the three existing pools would have to be -0.46 m, -0.26 m, and -0.06 m, respectively.

4.1.4.2.3 Install More Pools on the Upstream Side of the Fishway

The exit weir would have to be lowered and modified into a notched weir like the three existing weirs. The elevations and depths of the other recommended pools that would be required are provided in Table 4.1.2. The new pools should be 3.05 m long as opposed to the 1.83 m length of the current pools.

Table 4.1.2 **Elevations and Water Depths of Improved Eel River Pool and Weir Fishway**

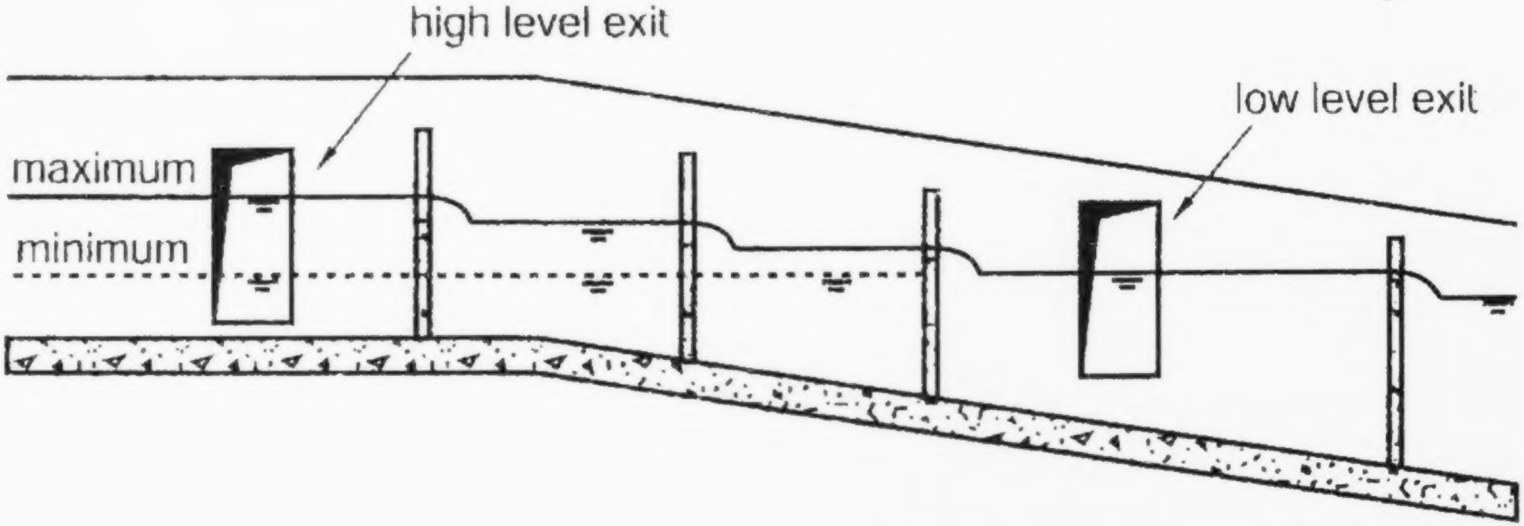
Downstream Weir or Pool	Current Bottom Elevation (m)	Current Baffle Elevation (m)	Required Baffle Elevation (m)	Pool Depth (m) after Baffle Modification	Required Bottom Elevation (m)
1	-0.15	0.76	0.76	0.91	-0.46
2	0.15	1.07	0.96	0.81	-0.26
3	0.46	1.37	1.16	0.71	-0.06
4	No pool yet	No pool yet	1.36	Not Applicable	0.14
5	No pool yet	No pool yet	1.56	Not Applicable	0.34
6	No pool yet	No pool yet	1.76	Not Applicable	0.54
7	No pool yet	No pool yet	1.96	Not Applicable	0.74
8	No pool yet	No pool yet	2.16	Not Applicable	0.94
9	No pool yet	No pool yet	2.36	Not Applicable	1.14
10	No pool yet	No pool yet	2.56	Not Applicable	1.34
11	No pool yet	No pool yet	2.76	Not Applicable	1.54

4.1.4.2.4 Employ Multiple Exits to Allow for Variable Water Height in the Impoundment

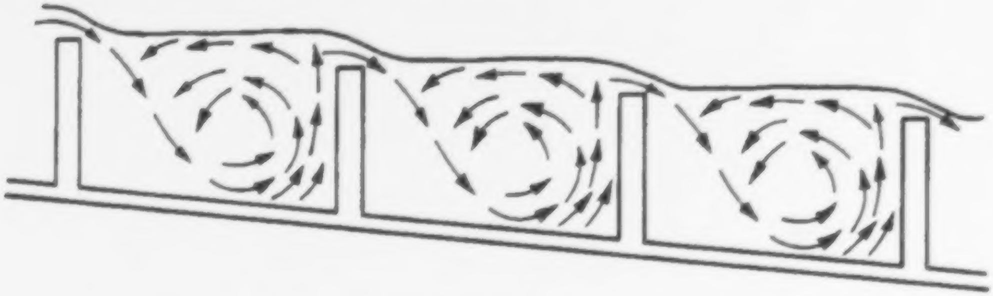
This would be required because the water elevation in the impoundment varies from 1.98 m to 2.74 m. Pools 7 through 11, inclusive, would require exit gates that can be drawn completely above the water's surface depending on the impoundment height. Only one gate would be elevated at any one time depending on the water surface height in the impoundment. These alternative exit pools would have to be over-sized to mitigate turbulence from the flow from the exit gate opening, which would be at a right angle to the flow in the rest of the fishway. This arrangement is demonstrated schematically in Figure 4.1.3, although only two exit gate openings are shown in this example, and doors instead of gates are employed. In the modified Eel River fishway, gates would also be located in the interconnecting pools.

4.1.4.2.5 Incorporate Streaming Rather than Plunging Flow Over Weirs.

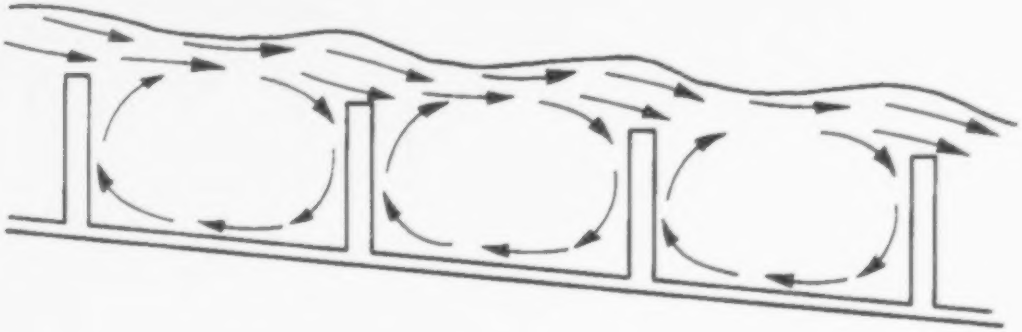
Shad and gaspereau do not jump and have difficulty passing upstream under plunging flow conditions, in which the water falls off the edge of the weir, creating a counter-clockwise vertical curl in the pool (Figure 4.1.4 (Clay, 1995)). Salmon use this type of flow very well because they use the momentum of the back-curl to help propel them into the air. Salmonids, gaspereau and shad can use streaming flow (Figure 4.1.4) which creates a clockwise (when observing from the true right side of the pool) vertical curl as a result of high water velocities over the weir, or by an elongated sloping apron installed in the weir notch that delivers the flow to the surface (Clay, 1995). Such aprons would be incorporated into the notches of modified Eel River fishway weir notches, and perhaps onto the main portion of the weir as well.


high level exit
low level exit
maximum
minimum

Pool and Weir Fishway with High and Low Level	Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **4.1.3**	NBDSS PROJECT No. YR101A



Plunging Flow



Streaming or Shooting Flow

Plunging Versus Streaming Fishway Flow (Clay, 1995)	Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **4.1.4**	NBDSS PROJECT No. YR101A

4.1.4.2.6 Attempt to Accommodate Rainbow Smelt

Rainbow smelt may be able to use the fishway if all of the above modifications were made. However, to improve the chances that rainbow smelt would be able to use a modified fishway, lower water velocity lines in the weir notch apron should be modified so that it is slightly V-shaped to create variable water velocities across its surface. The main portion of the weir could also be V-shaped to create variable water velocities related to depth. Roughening the shallower areas of flow would also create low velocity areas that might be used by smelt.

4.1.4.2.7 Provide Attraction Flow

Under many discharge and tidal conditions, fish are likely to have a problem finding the entrance to the fishway. There can be multiple discharge points from the impoundment including the gate openings, which are at the north (opposite) end of the gate array from the fishway, which is at the south side of the array. Fish would naturally be attracted to the gate region, particularly under high river flow conditions when the gate openings would be the primary discharge source from the impoundment. Discharge through the V-notch stoplog structure would also provide a distraction from the fishway for non-jumping, non-salmonid fish, which would have little opportunity to use this point of access to the impoundment. The fishway is contained within a walled raceway or bullpen that juts out into the Eel River estuary. There is no direct path from the splashdown point of water emanating from the V-notch stoplog and the entrance to the fishway. Under tidal conditions in excess of the level of the lower weir in the fishway (0.76 m), particularly on rising tides, there would be very little current discharging from the fishway as well as no turbulence-generated noise to indicate the location of the entrance to fish. Consequently, there are attraction issues with the current configuration. Additional flow could be piped and/or pumped from the impoundment to the entrance of the fishway to act as an attraction flow for upstream migrating fish. Air entrainment to this supplementary flow could be used to provide the turbulence that would provide an auditory signal to the fish as well.

4.1.4.3 Other Existing Fish Passage Issues

The effectiveness of the fishway to allow fish to pass over the dam is only one component of the fish passage issue. Other components of fish passage that must be addressed in order to meet the fish passage Project Objective include:

- differences in water temperature between the impoundment and the estuary below the dam;
- break-down of salt stratification due to total mixing of the water column downstream of the impoundment by plunging flow from the fishway and gate openings that is used by downstream migrating fish to acclimate to the marine environment;
- episodes of high water temperatures in the impoundment during the summer months;
- eutrophic conditions (excessive plant production) of the impoundment resulting in the clogging of the fishway pools with algae and a reluctance of upstream migrating fish to use the facility;

- increased predation and poaching (NBDNR, 1992) of fish, particularly adult Atlantic salmon below the dam as they wait for suitable conditions to pass through the fishway or over the spillway;
- increased predation of downstream migrating fish due to decreased water velocity in the impoundment and consequential effects on passage; and
- inability of the fishway to operate under icy conditions.

The potential modifications to the fishway described in Section 4.1.3.2 would do nothing to address issues related to water temperature and salt concentration differences. There would continue to be differences between water temperature and salt concentration above and below the dam unless there are unimpeded daily tidal events that create full mixing of fresh and saltwater. The fishway improvements would also do nothing to provide conditions where there is a freshwater layer on the top of the water column and a saltwater wedge underneath. This provides a vertical salt gradient that juvenile fish can move within to acclimate to full strength seawater. Similarly, without the influence of the daily tidal events, temperature extremes and eutrophic processes would continue in the impoundment.

The potential modifications considered above would also do nothing to alleviate the period that various fish species must "hold up" below the dam waiting for tidal conditions to become suitable. The Jacques Whitford Study Team observed several Osprey (*Pandion haliaetus*) fishing simultaneously in the waters immediately downstream of the dam. Since several, annually active Osprey nests have been documented in the near vicinity (Section 3.6.2), it is likely that this is a common fishing spot for Osprey. As well, large numbers of Loons (*Gavia sp.*) have been observed using the impoundment (Section 3.6.2) and it is likely that this species also takes advantage of fish waiting below the dam for suitable tidal conditions. These birds would also take advantage of the delayed migration of downstream migrants within the slow flowing impoundment.

Finally, during the winter months, ice conditions at the dam structure may prevent operation of the fishway which could limit effective upstream migration of Atlantic tomcod and downstream migration of the other anadromous species (fish that migrate into freshwater from saltwater to spawn).

4.1.5 Summary

In summary, making modifications to the fishway structure would improve fish passage for some species at some times, but would not effectively achieve the fish passage Project Objective of providing for the unimpeded and safe movement, upstream or downstream, of fish between aquatic habitats required to complete their life cycle. Some species would continue to have physical difficulty getting over the dam, and all species would still be exposed to marked changes in temperature and salinity upstream of the dam and increased predation below the dam. As well, the presence of ice during the winter months could affect operation of the fishway, thus limiting the upstream and downstream movement of fish species, primarily tomcod.

5.0 PROJECT DESCRIPTION AND IMPLEMENTATION STRATEGY

The Project is defined as the Decommissioning of the Eel River dam, including the earthen dyke, concrete water control structure, and associated infrastructure (*e.g.*, fish passage facilities). The Project is intended to address fish passage and other environmental and ecosystem issues associated with the Eel River dam. To that end, the following Project Objectives have been identified:

- long-term solution to fish passage;
- establishment of conditions that lead to the natural re-establishment of saltmarsh wetlands (low coastal grassland frequently overflowed by the tide) upstream of the Eel River dam; and
- improvement of habitat for softshelled clams and shellfish upstream and downstream of the Eel River dam.

In support of these Project Objectives, the Project Design Criteria listed below have also been established.

- the minimum width of an opening in the Eel River dam will be sufficient to allow tidal exchange to occur in a manner that is not substantially different (similar tidal prism, range and exchange) from the pre-dam condition. This opening should be located at the north end of the dam to reflect the pre-dam channel location;
- the Project should not result in a non-permitted prohibition of the *Species at Risk Act* (*SARA*) or a violation of the New Brunswick *Endangered Species Act*;
- the Project should allow for the free passage of ice so that there is no potential for ice-jamming;
- sedimentation of the Eel River estuary as has occurred because of the dam construction should be arrested;
- there should be no further constriction of the tidal inlet channel at the mouth of the estuary and in the vicinity of the bridge on Route 134;
- the Aboriginal Heritage Gardens should be protected; and
- during the implementation of the Project, sediment generated during the Decommissioning activities must be controlled.

The Project will employ strategies to mitigate potential negative environmental effects to ecological and socio-economic features that have adapted or developed since the dam was constructed. An adaptive management approach to dam removal will be implemented to ensure that significant negative environmental effects are avoided, should the Project proceed, subject to the outcome of the EIA.

5.1 The Project

The implementation of the Project will proceed in stages as follows:

- Stage 1 – design, permitting, planning, and communication;
- Stage 2 – create an opening in the north portion of Eel River dam; and
- Stage 3 – remove the remainder of the Eel River dam.

The following sections describe the stages, which form the strategy for implementing this Project. Table 5.1.1 below provides a breakdown of the estimated capital costs of the Project.

Table 5.1.1 Capital Costs of Project

Activity for Implementation of Project	Cost
Stage 1	
Engineering, drawings, and specifications for Stages 2 and 3	$170,000
Permitting	$30,000
Baseline follow-up and monitoring and communication program	$100,000
Sub total Stage 1	**$300,000**
Stage 2	
Mobilization, site preparation	$60,000
Erosion protection on north side of Eel River on either side of the existing dam	$300,000
Construct access from south end of dam to main portion of the dam	$50,000
Turbidity/silt control barriers installation and removal	$550,000
Removal of 150 m of the dam (5,200 m^3) and place rip-rap on north end of the remainder of the dam	$110,000
Follow-up and monitoring	$30,000
Sub total Stage 2	**$1,100,000**
Stage 3	
Mobilization, site preparation	$45,000
Turbidity/silt control barriers installation and removal	$120,000
Removal of remainder of dam (15,000 m^3)	$410,000
Follow-up and monitoring for 3 years	$60,000
Sub total Stage 3	**$635,000**
Total Cost for Project	**$2,035.000**

*all values in 2005 dollars
**all numbers have a built in 25% contingency

5.1.1 Stage 1 – Design, Permitting, Planning and Communication

Stage 1 includes activities relating to design, acquisition of permits and communication that must be carried out prior to creating the opening in the dam.

5.1.1.1 Design

It is important to note that the configurations provided in this EIA Report are at a conceptual level only. The fundamental design principles have been established and about 20 to 30 percent of the engineering has been completed. The design process to be undertaken during implementation would involve the processes described below.

Feasibility Level Engineering is where the design concept is fully advanced from both a technical and financial standpoint. At that level, about 60 to 70 percent of the engineering is completed, and the construction costs can be estimated to -10 to +25 percent of expected final cost. Engineering analyses are well advanced at this level, however refinements to the analyses will typically be required based on detailed design considerations. This process can take 3 to 6 months.

Detailed Design Engineering and Development of Decommissioning Drawings and Specifications occurs once all analyses and evaluations have been completed, accounting for detailed design information. Engineering is completed to nearly 100 percent (except for possible field adjustments during Decommissioning). The Decommissioning costs can be estimated to ±10 percent of expected final cost. Drawings and specifications suitable for tender are developed. This process can take 3 to 6 months to prepare.

5.1.1.2 Permitting and Planning

All necessary permits, approvals, and authorizations that are required to carry out Stage 2 and Stage 3 will be acquired during Stage 1. Additional field investigations required in support of these requirements will also be carried out during Stage 1. Monitoring and compensation required as conditions of the permits, approvals, and authorizations may extend beyond Stage 1 as appropriate.

The preparation of an Environmental Management Plan (EMP), including supporting plans and procedures (*e.g.*, emergency response and contingency plans) will be completed during Stage 1. Further details regarding the EMP are provided in Section 5.4.

5.1.1.3 Communication

An integral part of Stage 1 will be a communication program that will advise the public, stakeholders, and Aboriginal Community of the Project and how the implementation of the overall Project will be carried out, including contingency plans. Following a decision on the execution and timing of the Project, meetings will be held with the key stakeholders to determine the most appropriate means of communication and consultation during the implementation of the Project. This would be documented in a Communication Plan.

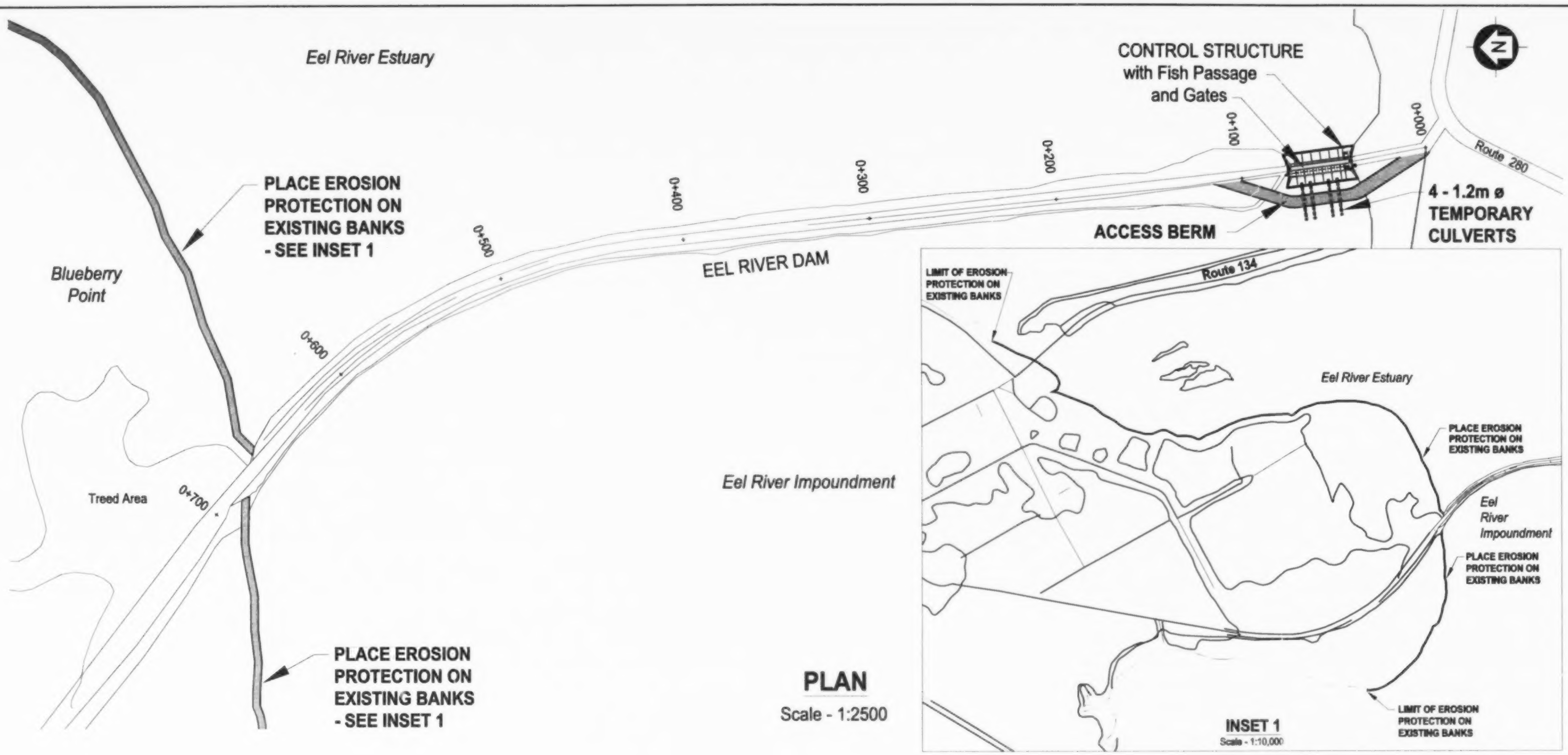
5.1.2 Stage 2 – Create a 150 m-Wide Opening in the Dam

A 150 m-wide opening will be created in the north end of the dam as part of Stage 2, as indicated on Figure 5.1.2. As discussed in Chapter 6, the width of the opening must be at least 100 m wide for the dam to establish hydrodynamic conditions that are similar to the pre-dam Eel River system. In light of this, a width of 150 m is recommended.

During Stage 2, the existing gates will be used to control flows. Erosion protection will be placed on the north bank of Eel River within the limits shown on Figure 5.1.1. The erosion protection will consist of vegetation and/or natural amendments on either side of where the dam currently abuts the north shoreline. Rockfill rip-rap will be placed at the north abutment as the dam is being removed. The erosion protection measures on either side of the dam abutment will be constructed with light construction equipment with low tire pressures and limiting distrubance of the landward side of the shoreline. Access to the north shore will be along existing roads without a requirement for clearing or road improvements. If additional access roads are required near the shoreline, then they will be constructed of granular fill over a geotextile and removed after construction is completed with the disturbed areas rehabilitated. A post-construction monitoring program would be implemented to determine if the vegetation is established as required and, if not, other measures would be undertaken to rehabilitate the shoreline. A detailed assessment of the location of the erosion protection measures will be undertaken in Stage 1.

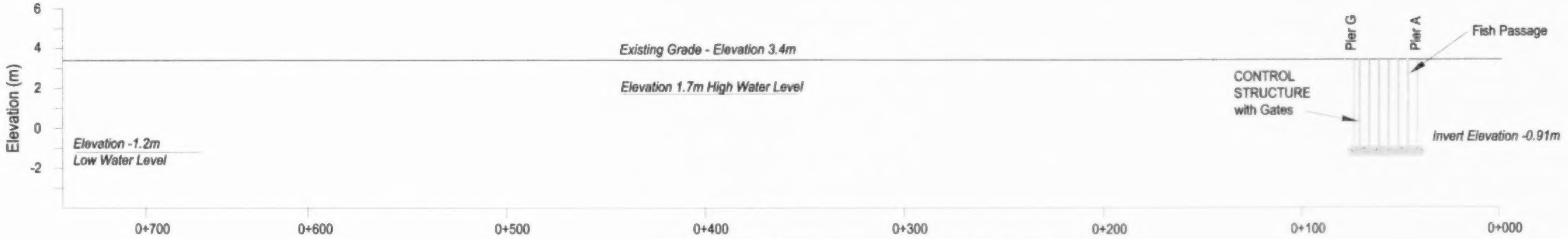
The mobilization and movement of sediment will be minimized during Decommissioning as shown in Figure 5.1.2. The proposed method involves the placement of sediment control barriers (also referred to as turbidity curtains) to isolate the Decommissioning area; construction of a barrier made of clean rockfill to moderate flow velocities in the area as the dam is removed (to protect the work area for worker safety and environmental reasons); followed by removal of the rockfill barrier and the turbidity curtains after the water quality (suspended sediment levels) in the area has reached acceptable levels. The Decommissioning steps are outlined below.

- Place the three turbidity/sediment control barriers. This will require anchoring to the bottom of Eel River impoundment and estuary below the dam.
- Place the rockfill barrier between the two easterly turbidity/sediment control barriers. These two turbidly/sediment control barriers will be used to contain sediment that will be generated through disturbance of the river bottom by the rockfill placement. This barrier is intended to moderate the flow velocities in the area that are expected during changes in water levels during the tides, particularly in the early stages of the excavation when the opening will be the smallest and the velocities will be highest. The rockfill barrier is to be constructed from the south to the north, with no heavy equipment permitted on the north shoreline. The turbidity/sediment control barrier on the west side of the rockfill barrier will be protected against high velocities by the rockfill barrier. The turbidity/sediment control barrier on the east side of the rockfill barrier may have to be removed during Decommissioning as it could be damaged by currents.
- Excavate the north end of the Eel River dam for a distance of 150 m, working from the north to the south with the sediment that will be generated by this activity contained between the turbidly/sediment control barriers.
- As the initial 150 m of the dam is being excavated, rip-rap will be placed on the north bank of the river at the former location of the dam abutment. After the 150 m section has been removed, then, depending on the time span between Stages 2 and 3, rockfill rip-rap may have to be placed on the north end of the remainder of the dam prior to Stage 3.


Eel River Estuary
CONTROL STRUCTURE with Fish Passage and Gates
0+000
0+100
0+200
0+300
0+400
0+500
0+600
0+700
Route 280
4 - 1.2m ø TEMPORARY CULVERTS
ACCESS BERM
PLACE EROSION PROTECTION ON EXISTING BANKS - SEE INSET 1
Blueberry Point
EEL RIVER DAM
Treed Area
Eel River Impoundment
PLACE EROSION PROTECTION ON EXISTING BANKS - SEE INSET 1
LIMIT OF EROSION PROTECTION ON EXISTING BANKS
Route 134
Eel River Estuary
PLACE EROSION PROTECTION ON EXISTING BANKS
Eel River Impoundment
PLACE EROSION PROTECTION ON EXISTING BANKS
LIMIT OF EROSION PROTECTION ON EXISTING BANKS
INSET 1
Scale - 1:10,000

PLAN

Scale - 1:2500


6
4
2
0
-2
Elevation (m)
Existing Grade - Elevation 3.4m
Elevation 1.7m High Water Level
Elevation -1.2m
Low Water Level
Pier G
Pier A
Fish Passage
CONTROL STRUCTURE with Gates
Invert Elevation -0.91m
0+700
0+600
0+500
0+400
0+300
0+200
0+100
0+000

EXISTING PROFILE ALONG DAM

Scale - 1:2500 Horiz. 1:250 Vert.

NOTE: 1. EROSION PROTECTION SHOWN ON THIS DRAWING TO BE PLACED WITH LIGHT EQUIPMENT AND LIMITED TO THE LANDWARD SIDE OF DISTURBANCE. THE SHORELINE AND ACCESS ROADS ARE TO BE TEMPORARY AND REMOVED AFTER CONSTRUCTION IS COMPLETE, WITH THE DISTURBED AREAS REHABILITATED.

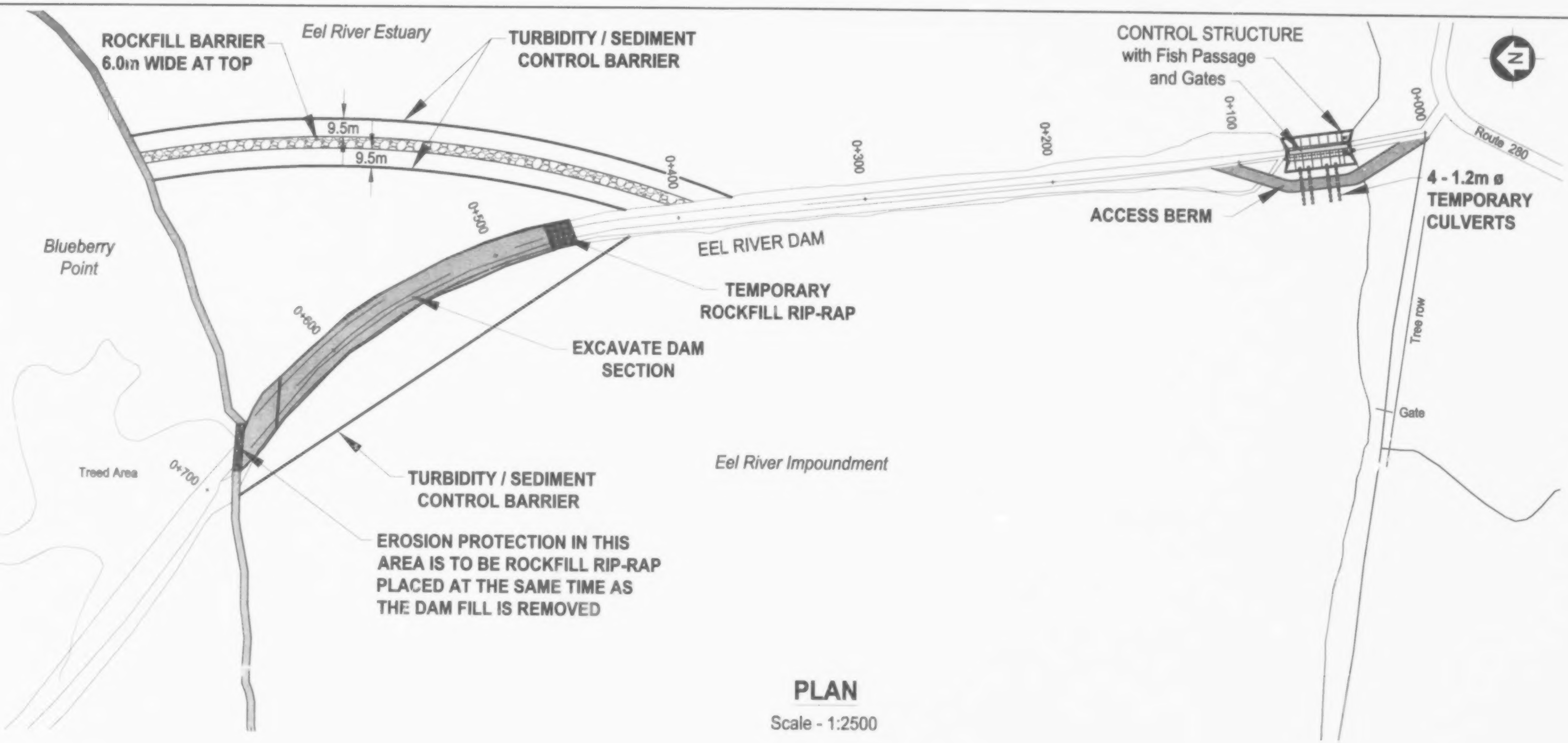
STAGE 2
PREPARATORY WORK
PLAN AND PROFILE

Date: 2006 03 31
Scale: AS SHOWN
Job No.: 15830
Fig. No.: 5.1.1

Eel River Dam

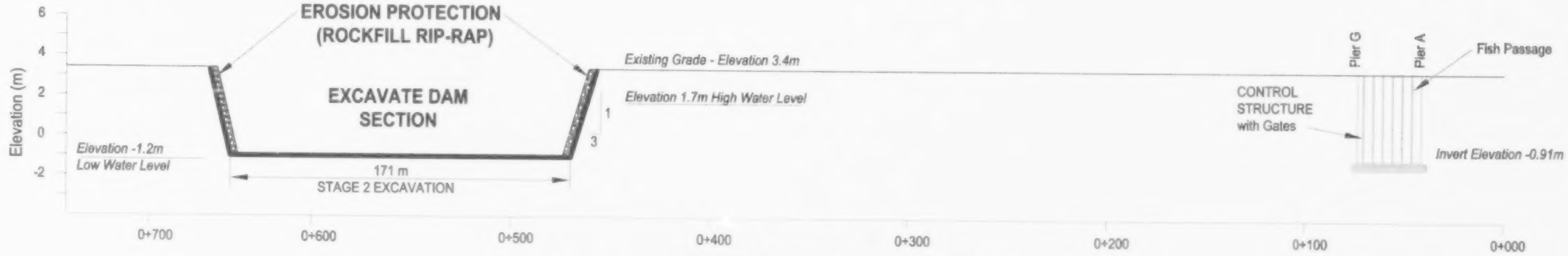
NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\DAM REMOVAL


ROCKFILL BARRIER
6.0m WIDE AT TOP
Eel River Estuary
TURBIDITY / SEDIMENT
CONTROL BARRIER
9.5m
9.5m
CONTROL STRUCTURE
with Fish Passage
and Gates
0+000
0+100
0+200
0+300
0+400
0+500
0+600
0+700
Route 280
4 - 1.2m ø
TEMPORARY
CULVERTS
ACCESS BERM
EEL RIVER DAM
Blueberry
Point
TEMPORARY
ROCKFILL RIP-RAP
EXCAVATE DAM
SECTION
Tree row
Gate
Treed Area
Eel River Impoundment
TURBIDITY / SEDIMENT
CONTROL BARRIER
EROSION PROTECTION IN THIS
AREA IS TO BE ROCKFILL RIP-RAP
PLACED AT THE SAME TIME AS
THE DAM FILL IS REMOVED

PLAN

Scale - 1:2500


6
4
2
0
-2
Elevation (m)
EROSION PROTECTION
(ROCKFILL RIP-RAP)
EXCAVATE DAM
SECTION
Existing Grade - Elevation 3.4m
Elevation 1.7m High Water Level
1
3
Elevation -1.2m
Low Water Level
171 m
STAGE 2 EXCAVATION
Pier G
Pier A
Fish Passage
CONTROL
STRUCTURE
with Gates
Invert Elevation -0.91m
0+700
0+600
0+500
0+400
0+300
0+200
0+100
0+000

EXISTING PROFILE ALONG DAM

Scale - 1:2500 Horiz. 1:250 Vert.

SUGGESTED CONSTRUCTION SEQUENSE

1. Place turbidity /sediment control barriers. These will be anchored to the bottom of Eel River estuary.
2. Place rockfill barrier between the two easterly turbidity/sediment control barriers.
3. Excavate Eel River dam between stations 0+457 and 0+679 with sediment contained by turbidity/sediment control barriers.
4. Remove rockfill barrier.
5. Remove turbidity/sediment control barriers after water quality between the barriers is acceptable. A flocculent may be required to promote settling of suspended sediments.
6. Heavy construction equipment is not permitted on Blueberry Point. All access is to be from the south end of the dam.

STAGE 2
CONSTRUCTION METHODOLOGY
PLAN AND PROFILE

Date: 2006 03 31

Scale: AS SHOWN

Job No.: 15830

Fig. No.: 5.1.2

Eel River Dam

NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\DAM REMOVAL

- After the suspended sediment levels in the excavation area have reduced to acceptable levels through settling, then the rockfill barrier will be removed starting at the southern end of the rockfill barrier and removing towards the north. The easterly turbidly/sediment control barrier will be removed after the suspended sediment levels resulting from the rockfill barrier removal have reached acceptable levels. The remaining turbidity/sediment control barriers will be removed after the rest of the area has reached acceptable levels of suspended sediments. The construction schedule will include an appropriate amount of time for setting in fines. As a contingency measure, an environmentally acceptable flocculent may be used to accelerate the reduction in suspended sediment levels.

The excavation work would proceed from the north to the south.

The material removed from the dam is uncontaminated soil, rockfill, and construction debris and can be disposed of in areas requiring clean fill. The disposal location for the material will be identified by the contractor undertaking the work. The tender documents will request identification of the disposal location and this will be considered as part of the tender evaluation. The location must be approved by the applicable regulatory agencies prior to disposal. Opportunities to recycle the material will be preferred. It is unlikely that this material will be disposed of in the landfill.

During the construction activities, the contractor will not be permitted to establish an "equipment laydown area" on the Eel River First Nation Reserve. If such a laydown area is required, then the contractor will be expected to identify this during the tendering process for review by the applicable regulatory agencies. The site for a laydown area should be in a previously disturbed area and avoid archaeological resources, rare plants, migratory birds, wetlands, watercourses and other identified environmentally sensitive areas. The laydown area would be designed to prevent contamination of the area through fuel spills or other refuse.

In addition, the Contractor will not be permitted to travel with heavy construction equipment (large excavators, dump trucks, and bulldozers) on Blueberry Point, the landward side of the north shoreline. Access for heavy equipment is to be from the south end of the dam where roads currently exist.

To provide access to the south end of the dam for heavy construction equipment, it will not be possible to travel across the existing control structure. An access berm of clean rock fill will be constructed upstream of the control structure as shown on Figure 5.1.1. The access berm will include four 1.2 m diameter culverts to maintain the flow of water.

5.1.3 Stage 3 – Remove Remainder of Dam

The remainder of the dam would be removed by excavating in a southerly direction from the initial 150 m opening as shown on Figure 5.1.3. As noted above, this may also involve rip-rap that had been placed on the north end of the remainder of the dam after Stage 2 was completed. This could be done without the use of the rockfill barrier. However, turbidity/sediment control barriers would likely be required. The need for these systems would be established during Stage 2 prior to excavation activities.

The existing control structure will be removed and the original shoreline re-established.

5.1.4 Alternative Means of Carrying Out the Project

Alternative means of carrying out the Project include alternative methods for removing the dam, alternative erosion and sediment control measures, and alternative methods for removing the control structure.

5.1.4.1 Alternative Methods for Removing the Dam

This EIA was originally conceived to include consideration of a partial dam removal and a full dam removal. The partial dam removal alternative was not considered as a viable alternative means of removing the dam as a result of consultation with the ERBFN, where it was identified that only full removal would be considered acceptable. In addition, there were no substantive environmental benefits identified for the partial removal alternative.

5.1.4.2 Alternative Methods for Removing the Control Structure

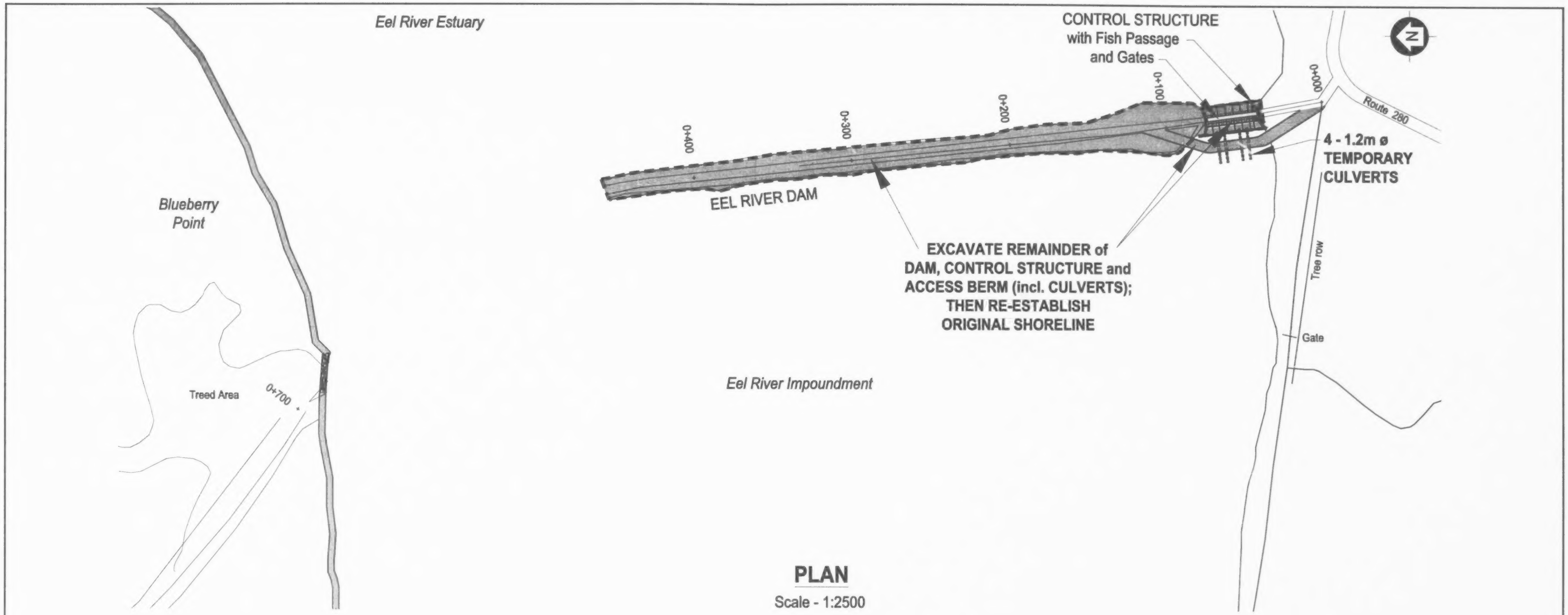
Instead of removing the entire control structure, just the deck and girders could be removed and the remaining structure filled in with excavated material from the dam, with an estimated cost of $30,000 as compared to $150,000 for completely removing the structure and the original riverbank re-established. However, in keeping with the Coastal Areas Protection Policy (CAPP) of New Brunswick, this approach (infilling) is considered not acceptable and full removal of the dam structure is therefore required.

5.1.4.3 Alternative Erosion and Sediment Control Measures

As an alternative to the use of the turbidity/sediment control barriers and rockfill barrier presented in Figure 5.1.2, water tight cofferdams could be constructed to isolate the Decommissioning area and prevent the release of sediment beyond the Decommissioning area. Such cofferdams would be constructed of sand and gravel and would have a core constructed of clay, steel sheet piles, or high density polyethylene sheets. The cofferdams would be designed and constructed to limit seepage into the area. Water entering the area could be pumped from the area to allow for removal of the dam "in the dry" or by keeping the water level in the area below the water level in Eel River impoundment and Eel River estuary, then there would be no loss of sediment from the area. The challenges associated with this alternative are as follows:

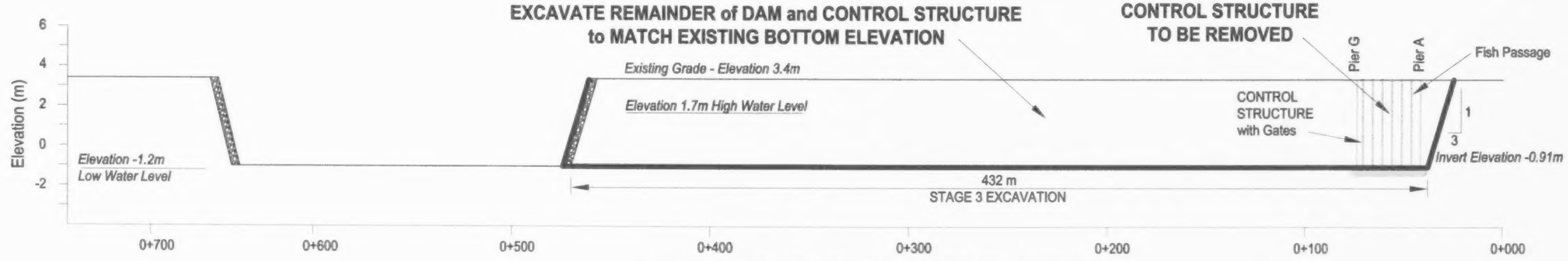
- removal of the earthfill portions of the cofferdam could lead to unacceptable levels of suspended sediment and would require the use of turbidity/sediment control barriers during their construction; and
- dewatering the Decommissioning area would require the construction of a sedimentation pond and a pumping system.

Since turbidity/sediment control barriers would be required in any event, the rockfill method described in Section 5.1.2 is recommended to moderate flows in the construction area and minimize the mobilization of sediment during Decommissioning.


Eel River Estuary
CONTROL STRUCTURE with Fish Passage and Gates
N
0+000
0+100
0+200
0+300
0+400
Route 280
4 - 1.2m ø TEMPORARY CULVERTS
EEL RIVER DAM
EXCAVATE REMAINDER of DAM, CONTROL STRUCTURE and ACCESS BERM (incl. CULVERTS); THEN RE-ESTABLISH ORIGINAL SHORELINE
Blueberry Point
Tree row
Gate
Treed Area
0+700
Eel River Impoundment

PLAN

Scale - 1:2500


EXCAVATE REMAINDER of DAM and CONTROL STRUCTURE to MATCH EXISTING BOTTOM ELEVATION
CONTROL STRUCTURE TO BE REMOVED
Pier G
Pier A
Fish Passage
Existing Grade - Elevation 3.4m
Elevation 1.7m High Water Level
CONTROL STRUCTURE with Gates
1
3
Invert Elevation -0.91m
Elevation -1.2m
Low Water Level
432 m
STAGE 3 EXCAVATION
Elevation (m)
6
4
2
0
-2
0+700
0+600
0+500
0+400
0+300
0+200
0+100
0+000

EXISTING PROFILE ALONG DAM

Scale - 1:2500 Horiz. 1:250 Vert.

FILE: 15830\EIA REPORT\DAM REMOVAL

NOTE:	STAGE 3 REMOVE REMAINDER OF DAM PLAN AND PROFILE	Date: 2006 03 31	Scale: AS SHOWN	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
		Job No.: 15830	Fig. No.: 5.1.3	NBDSS PROJECT No. YR101A

5.2 Schedule

Stage 1 would take approximately one year, with Stage 2 taking one to two years to complete, depending on the timing for Decommissioning. Stage 3 would take one year to complete, although the follow-up would continue for three years.

5.3 Accidents, Malfunctions and Unplanned Events

This section presents the accidents, malfunctions and unplanned events scenarios that may occur as a result of Project implementation, and describes the potential accidents and malfunctions that are considered in the environmental effects assessment (Chapter 7).

All necessary precautions will be taken to prevent the occurrence of accidents, malfunctions and unplanned events that may occur throughout all stages of the Project and to minimize any environmental effects should they occur. As noted in Section 5.4, the EMP will include Emergency Response and Contingency Plan to address these situations. Decommissioning will follow the EMP developed for the Project and the relevant regulations, guidelines and accepted industry procedures prescribed therein.

The Water Resources VEC (Section 7.6) includes an analysis of the potential for groundwater and surface water contamination as a result of the Project. Similarly, the Heritage and Archaeological Resource VEC (Section 7.12) includes an analysis of the potential for accidental or unplanned disturbance of heritage or archaeological resources and the Transportation Network (Section 7.8) considers the potential for vehicle accidents during Project implementation.

Given the implementation of the EMP and the accidents assessed specifically as part of other VECs, the residual accidents and malfunctions with the greatest potential for significant environmental effects include hazardous material spills and unplanned erosion (*i.e.*, beyond the pre-dam river channel).

5.3.1 Hazardous Material Spills

Spills of petroleum, oils, or lubricants (POLs) may occur during refueling of machinery or through breaks in hydraulic lines. These spills are usually highly localized and easily cleaned up by on-site crews using standard equipment. In the unlikely event of a large spill, soil, groundwater, and surface water contamination may occur, potentially negatively affecting the quality of groundwater, fish and fish habitat, and wetland habitat, thus resulting in the ingestion/uptake of contaminants by wildlife. Depending on the nature of the spill, it could also potentially affect residential, commercial, agricultural, and other land uses.

POLs and other hazardous materials will be handled in accordance with applicable regulations (*e.g.*, the *Petroleum Product Storage and Handling Regulation*). Procedures will be outlined in the EPP for construction (Section 5.4) including inspecting construction equipment to detect possible fuel and hydraulic system leaks and repairing as necessary. Refuelling and equipment maintenance will be conducted away from residential properties, and not within 30 m of a wetland or watercourse. Refuelling will be conducted on level terrain and on a prepared impermeable surface with a collection system.

The Emergency Response and Contingency Plan (Section 5.4) will address response procedures for Project-related hazardous material spills. This will ensure that in the unlikely event of a hazardous material spill, appropriate measures, materials and training are in place to minimize the potential environmental effects.

Vehicle-related spills during Project implementation are considered where traffic flow has been disrupted or impeded as a result of Project activities.

5.3.2 Unplanned Erosion

As noted in Section 5.1.1, erosion control measures will be placed in appropriate areas as part of Stage 2 for the Project. These erosion control measures will be monitored and repaired, as required, during Stages 2 and 3. The Follow-up Program (Chapter 10) outlines a plan to monitor channel evolution and unplanned erosion. Where identified, mitigation measures would be implemented to control unplanned erosion.

5.4 Environmental Management Plan

An Environmental Management Plan will be developed for the Project. The purpose of the EMP is to provide protection of the environment for the life of the Project by:

- ensuring compliance with the commitments as set forth in the EIA Report;
- ensuring compliance with environmental legislation, regulations, and conditions of approval;
- ensuring that the environmental effects of accidents, malfunctions and unplanned events, should they occur, are minimized; and
- outlining a Follow-up Program to verify the accuracy of environmental effects predictions in the EIA and determine the effectiveness of mitigation recommended in the EIA Report.

The EMP will include an Environmental Protection Plan (EPP), Standard Operating Procedures (SOPs), an Emergency Response and Contingency Plan, and a Follow-up Program for the full life of the Project. The EMP will also define and identify roles and responsibilities, accountability, and reporting procedures.

The EMP will be developed during Stage 1 of the Project. During Stage 2, any previously identified sensitive areas (*i.e.*, riverbank upstream and downstream of the dam opening) will be monitored, and the results may be used to iteratively update the EMP (*e.g.*, identify specific types of erosion control measures for specific locations). The EMP and its supporting documents and procedures will be submitted to the Director of Project Assessment Branch at NBENV and other regulatory authorities for review and approval prior to the initiation of Stage 2 of the Project.

5.4.1 Environmental Protection Plan

The EPP is a vital common reference document for implementing environmental protection measures and providing environmental protection procedures. The EPP will be designed to ensure that the construction and operation-related commitments of the EIA and other regulatory permits (*e.g.*, Watercourse and Wetland Alteration Permit) are followed. The EPP will use the EIA Report and supporting documents to identify environmentally sensitive areas and concerns and recommended mitigation measures. The EPP will contain SOPs and the Emergency Response and Contingency Plan. The emergency response and contingency plans for spills of petroleum, oils, lubricants and other hazardous materials will be outlined in the EPP. In developing the contingency plan, the Canadian Standards Association publication Emergency Preparedness and Response, CAN/CSA-Z731-03, will be consulted as one of the useful references. All spills or leaks, such as those from machinery or fuel storage tanks, will be promptly contained and cleaned up (sorbents and booms will be available for quick containment and recovery), and reported to the 24-hour environmental emergencies reporting system (1-800-565-1633).

The purpose of each SOP is to provide a description of the best practice mitigation measures to be used during Project implementation. SOPs will provide instructions or steps to be followed to complete the required tasks in an efficient and consistent manner that meets the commitments set forth in the EIA and other regulatory permits.

The EPP will be developed prior to the commencement of Stage 1 works and Stage 2 of the Project and will be submitted in phases to the appropriate regulatory agencies for review. The proposed table of contents for the EPP has been included in Table 5.4.1 in order to allow an opportunity for feedback prior to its detailed development.

Table 5.4.1 Proposed Table of Contents, Environmental Protection Plan

- 1.0 Introduction
- 2.0 General Measures
  - 2.1 Employee Awareness Training
- 3.0 Notification of Concerned Parties
- 4.0 Access Management
- 5.0 Procedures for Stages 2 and 3
  - 5.1 General Measures
  - 5.2 Operations In and Near Waterbodies
  - 5.3 Erosion Protection
  - 5.4 Noise and Dust Control
  - 5.5 Equipment Idling Procedures
  - 5.6 Fisheries Protection

Table 5.4.1 Proposed Table of Contents, Environmental Protection Plan

- 5.7 Historic Resources Protection
- 5.8 Management of Dam Material
- 5.9 Construction of Erosion Protection Measures
- 5.10 Cleanup and Re-vegetation

6.0 Waste Management Plan
- 6.1 Guiding Principles
- 6.2 Descriptions of Effects of Wastes and Hazardous Materials
- 6.3 Handling, Storage, Use and Disposal

7.0 Spill Prevention Measures

8.0 Spill Contingency Plan
- 8.1 Spills Adjacent to or into a Body of Water
- 8.2 Spot Spills
- 8.3 Reclamation of Spill Area

9.0 Emergency Response

5.4.2 Follow-up Program

A Follow-up Program will be designed and executed to fulfill the need for and the requirements of a Follow-up Program as outlined in the Guidelines and *CEAA*. The objectives of the Follow-up Program will be to verify the accuracy of the EIA and determine the effectiveness of any measures taken to mitigate the negative environmental effects of the Project.

The recommended elements of the Follow-up Program are presented in Chapter 10 of this EIA Report.

6.0 PREDICTED FUTURE ENVIRONMENT

The environmental effects of removing the Eel River dam on the future physical and chemical environments were predicted using hydrodynamic modelling, trend analysis, and the professional judgment of the Jacques Whitford Study Team. Modelling objectives, scenarios and existing conditions are contained in the following sections as well as the results of the hydrodynamic modelling and the predicted future hydrodynamic, water quality and geomorphological conditions as a result of the removal of the Eel River dam. The hydrodynamic model set-up, model input and model calibrations for the removal of the Eel River dam are contained in Appendix B.

6.1 Hydrodynamic Conditions

The hydrodynamic conditions refer to the flow of surface water, including the tides, within the Eel River estuary from the Village of Eel River Crossing to the marine environment near to the tidal inlet in Eel Bay. The Eel River watershed which includes the hydrodynamically modelled area and the location of two Environment Canada hydrometric stations is presented in Figure 1.1.1.

6.1.1 Hydrodynamic Modelling Objectives

The proposed project undertaking involves removal of the Eel River dam beginning with a 100 m opening, and proceeding to complete removal of the dam. The removal of the Eel River dam will change the hydrodynamic conditions in the Eel River estuary. These changes may in turn result in geomorphological changes in the forms of erosion, sedimentation, and channel realignment in the impoundment area, the Eel River estuary, the tidal inlet, and Eel Bay near the tidal inlet. Therefore, the objectives of the hydrodynamic modelling were to evaluate the expected long-term hydrodynamic conditions for the Eel River estuary for the proposed dam removal strategy. Results from the hydrodynamic modelling served as input in the geomorphological evaluations, water quality evaluations, and other environmental effects evaluations associated with saltwater inflow into the impoundment, and tidal water level fluctuations. The model developed for this study was also used to assist in the development of a dam removal strategy.

The focus of the hydrodynamic modelling was to evaluate the hydrodynamic changes in the impoundment and Eel River estuary area as a whole. Localized changes in specific areas of the estuary have not been evaluated with the present modelling effort, which is not considered necessary.

6.1.2 Hydrodynamic Modelling Scenarios

The calibrated hydrodynamic model, discussed in detail in Appendix B, was used to model the existing and predicted future hydrodynamic conditions in the estuary. For the existing conditions, the modelling was conducted to evaluate the hydraulic capacity at the tidal inlet in consideration of the increased tidal prism, assuming the existing geometry of the tidal inlet will be maintained. The model was also used to evaluate the estimated future geometry at the tidal inlet.

For predicting future hydrodynamic conditions in the estuary, the hydrodynamic modelling considered 100 m opening and full dam removal scenarios. For full dam removal, the impoundment and the Eel River estuary were considered together and flow across the Eel River dam was not simulated. For 100 m opening, it was assumed that an opening was created though the dam. The opening may or may not include the gates incorporated into the water control structure. For the two modelling scenarios, it was also evaluated that erosion will occur to the bottom of the tidal inlet to an elevation similar to the pre-dam conditions, which had an elevation of approximately -1.8 m. This elevation is 0.8 m lower than the existing elevation of approximately -1.0 m.

Two tidal scenarios were considered, one for mean tide and one for large tide. Three fresh water scenarios were considered, including mean annual flow, one in two year maximum daily flow (which approximately corresponds to mean annual flood typically occurring in the spring), and mean annual low flow. The combination of the above tide and freshwater flows can provide a range of the hydrodynamic conditions that may be expected with the proposed Eel River dam removal. For example, mean tide combined with mean freshwater flow would represent the average conditions. Mean annual low freshwater flow combined with a large tide would represent a tidal flow dominated estuary hydrodynamic condition. High fresh water flow combined with mean tide would represent the extent of freshwater domination in the hydrodynamics of the estuary during spring runoff conditions.

A summary of the modelling scenarios for the existing conditions is provided in Table 6.1.1. A summary of the modelling scenarios for future conditions is provided in Table 6.1.2.

6.1.3 Hydrodynamic Modelling for Existing Conditions

A summary of the modelling output for the existing conditions is presented in Table 6.1.1 which shows that the tidal inflow velocity for large tide and mean annual flow conditions reaches 1.5 m/s. This represents the typical high inflow velocity at the tidal inlet. For one in two year maximum daily flow and mean tide conditions, the peak outflow velocity reaches 1.8 m/s. This represents the typical high outflow velocity at the tidal inlet. These velocities represent the quasi-equilibrium conditions at the tidal inlet. It is expected that with the implementation of the removal strategy of the Eel River dam, the dimensions and geometry of the tidal inlet will increase until such flow velocities become re-established.

The tidal inflow into the Eel River estuary is affected by the fresh water flow. The modelling results indicate that under one in two-year maximum daily flow and mean tide conditions, there will be no tidal inflow into the Eel River estuary.

Under the existing conditions, the substrate elevations and freshwater flow govern the low water level in the Eel River estuary. However, due to the relatively limited storage, the water level in the Eel River estuary during a rising tide closely follows and is in phase with the tidal water level in Eel Bay, with essentially identical peak water levels.

Table 6.1.1 **Summary of Hydrodynamic Modelling Results for Evaluating Tidal Inlet**

ID	Tide		Freshwater Flow		Tidal Inlet				Estuary	Impoundment
	Description	Peak Level (m)	Description	Rate (m^3/s)	Peak Inflow Velocity (m/s)	Peak Inflow Rate (m^3/s)	Peak Outflow Velocity (m/s)	Peak Outflow Rate (m^3/s)	Peak Water Level (m)	Peak Water Level (m)
EXISTING CONDITION FOR EEL RIVER DAM, EXISTING GEOMETRY AT TIDAL INLET (30 m wide, invert at -1 m)										
INLET-A-1	Large Tide	1.7	Mean Annual Low Flow	0.41	1.57	104	1.24	61	1.68	n/a
INLET-A-2	Large Tide	1.7	Mean Annual Flow	5	1.50	99	1.28	64	1.69	n/a
INLET-A-3	Large Tide	1.7	1:2 Year High Flow	60	0.48	31	1.91	101	1.77	n/a
INLET-A-4	Mean Tide	1.1	Mean Annual Low Flow	0.41	1.12	60	1.00	40	1.07	n/a
INLET-A-5	Mean Tide	1.1	Mean Annual Flow	5	1.05	56	1.05	43	1.09	n/a
INLET-A-6	Mean Tide	1.1	1:2 Year High Flow	60	0.00	0	1.79	79	1.24	n/a
EEL RIVER DAM REMOVED, EXISTING GEOMETRY AT TIDAL INLET UNCHANGED (30 m wide, invert at -1 m)										
INLET-B-1	Large Tide	1.7	Mean Annual Low Flow	0.41	2.16	140	1.69	78	1.22	1.22
INLET-B-2	Large Tide	1.7	Mean Annual Flow	5	2.13	139	1.74	82	1.27	1.27
INLET-B-3	Large Tide	1.7	1:2 Year High Flow	60	1.76	123	2.21	121	1.65	1.65
INLET-B-4	Mean Tide	1.1	Mean Annual Low Flow	0.41	1.51	79	1.28	46	0.73	0.73
INLET-B-5	Mean Tide	1.1	Mean Annual Flow	5	1.48	78	1.33	50	0.78	0.78
INLET-B-6	Mean Tide	1.1	1:2 Year High Flow	60	1.01	58	1.85	83	1.15	1.15
EEL RIVER DAM REMOVED, TIDAL INLET WIDENED TO 100 m, INVERT CUT TO -1.8 m										
INLET-C-1	Large Tide	1.7	Mean Annual Low Flow	0.41	1.30	376	1.25	289	1.70	1.70
INLET-C-2	Large Tide	1.7	Mean Annual Flow	5	1.30	371	1.25	292	1.70	1.70
INLET-C-3	Large Tide	1.7	1:2 Year High Flow	60	1.09	317	1.45	333	1.70	1.70
INLET-C-4	Mean Tide	1.1	Mean Annual Low Flow	0.41	0.90	220	0.90	196	1.10	1.10
INLET-C-5	Mean Tide	1.1	Mean Annual Flow	5	0.85	215	0.92	196	1.10	1.10
INLET-C-6	Mean Tide	1.1	1:2 Year High Flow	60	0.65	163	1.13	234	1.10	1.10

Legend: n/a not applicable

Table 6.1.2 Summary of Hydrodynamic Modelling Scenarios and Modelling Results for Future Conditions

ID	Tide		Freshwater Flow		At Tidal Inlet				At Estuary	At Dam Opening				At Impoundment
	Description	Peak Level (m)	Description	Rate (m^3/s)	Peak Inflow Velocity (m/s)	Peak Inflow Rate (m^3/s)	Peak Outflow Velocity (m/s)	Peak Outflow Rate (m^3/s)	Peak Water Level (m)	Peak Inflow Velocity (m/s)	Peak Inflow Rate (m^3/s)	Peak Outflow Velocity (m/s)	Peak Outflow Rate (m^3/s)	Peak Water Level (m)
EXISTING CONDITIONS (opening width for tidal inlet at 30 m, invert at -1 m)														
E-1	Large Tide	1.7	Mean Annual Low Flow	0.41	1.57	104	1.24	61	1.68	n/a	n/a	n/a	n/a	n/a
E-2	Large Tide	1.7	Mean Annual Flow	5	1.50	99	1.28	64	1.69	n/a	n/a	n/a	n/a	n/a
E-3	Large Tide	1.7	1:2 Year High Flow	60	0.48	31	1.91	101	1.77	n/a	n/a	n/a	n/a	n/a
E-4	Mean Tide	1.1	Mean Annual Low Flow	0.41	1.12	60	1.00	40	1.07	n/a	n/a	n/a	n/a	n/a
E-5	Mean Tide	1.1	Mean Annual Flow	5	1.05	56	1.05	43	1.09	n/a	n/a	n/a	n/a	n/a
E-6	Mean Tide	1.1	1:2 Year High Flow	60	0.00	0	1.79	79	1.24	n/a	n/a	n/a	n/a	n/a
PARTIAL OPENING ALTERNATIVE (100 m opening width for Eel River Dam, tidal inlet widened to 100 m, invert cut to -1.8 m)														
P-1	Large Tide	1.7	Mean Annual Low Flow	0.41	1.20	360	1.21	280	1.70	1.36	268	1.28	201	1.69
P-2	Large Tide	1.7	Mean Annual Flow	5	1.19	354	1.26	284	1.70	1.34	262	1.30	204	1.69
P-3	Large Tide	1.7	1:2 Year High Flow	60	1.01	305	1.43	322	1.70	1.05	210	1.67	248	1.71
P-4	Mean Tide	1.1	Mean Annual Low Flow	0.41	0.83	212	0.88	196	1.10	0.94	154	1.00	151	1.10
P-5	Mean Tide	1.1	Mean Annual Flow	5	0.81	208	0.90	196	1.10	0.91	154	1.02	157	1.10
P-6	Mean Tide	1.1	1:2 Year High Flow	60	0.63	158	1.11	227	1.10	0.58	127	1.32	176	1.11
FULL REMOVAL ALTERNATIVE (Eel River Dam removed, tidal inlet widened to 100 m, invert cut to -1.8 m)														
F-1	Large Tide	1.7	Mean Annual Low Flow	0.41	1.30	376	1.25	289	1.70	n/a	n/a	n/a	n/a	1.70
F-2	Large Tide	1.7	Mean Annual Flow	5	1.30	371	1.25	292	1.70	n/a	n/a	n/a	n/a	1.70
F-3	Large Tide	1.7	1:2 Year High Flow	60	1.09	317	1.45	333	1.70	n/a	n/a	n/a	n/a	1.70
F-4	Mean Tide	1.1	Mean Annual Low Flow	0.41	0.90	220	0.90	196	1.10	n/a	n/a	n/a	n/a	1.10
F-5	Mean Tide	1.1	Mean Annual Flow	5	0.85	215	0.92	196	1.10	n/a	n/a	n/a	n/a	1.10
F-6	Mean Tide	1.1	1:2 Year High Flow	60	0.65	163	1.13	234	1.10	n/a	n/a	n/a	n/a	1.10

Legend: n/a not applicable

The water level in the impoundment is currently regulated through the water control structure, and the tidal water level in Eel Bay has little direct effect on the water level in the impoundment. The initial design maximum operating water level was 1.98 m. In 1969, a modification was made to the water control structure to increase the storage in the impoundment. It was estimated that this modification would allow the water level in the reservoir to be raised by an additional meter (BMA and CG&S, 2000), to 2.98 m. There is no data indicating the impoundment has been operated at this level.

6.1.4 Hydrodynamic Modelling Results

After dam removal, the tidal prism moving into and out of the Eel River estuary will increase from the present volume of 0.59 million m^3, to 1.9 million m^3. With the present opening width at the tidal inlet of approximately 30 m, the peak velocity for a large tide with mean annual freshwater flow will reach 2.1 m/s. A large tide is the average largest annual tide. This velocity is higher than the present quasi-equilibrium velocity of 1.5 m/s, and is not expected to be sustainable given the composition of the material at the tidal inlet, mainly sand and gravel. Therefore, it is expected that the opening at the tidal inlet will widen in response to the substantially increased tidal prism and related velocity increase. Using the hydrodynamic model established, it is estimated that the tidal inlet will widen to approximately 100 m. With this opening width, the flow velocity at the tidal inlet will ultimately be similar to the present conditions.

With the removal of the Eel River dam, the water level in the entire estuary, including the present Eel River estuary and impoundment area, will fluctuate with the tidal cycle (Figure 6.1.1). The modelling results indicate that the peak rise of the water level in the estuary will reach an elevation that is essentially the same as the high tide level in Eel Bay. For a mean and large tide, the water line in the estuary is presented in Figure 6.1.2. The maximum water level for a large tide in the estuary will reach approximately 1.7 m. This level is lower than the maximum operating water level of 1.98 m originally designed for the impoundment.

For an extreme tide, the tidal water level can reach 2.36 m, which is higher than the maximum operating water level maintained in the impoundment. An extreme tide is the highest tide ever recorded at Dalhousie. Currently, when the tide rises above the crest levels of the gates and the water level in the impoundment, there is some tidal water entering the impoundment. However, this saltwater intrusion is only for the duration when the tidal water level exceeds the water level in the impoundment and the crest levels of the gates. Due to the limited duration as well as the narrow dimension of the opening width, the tidal inflow into the impoundment is small and the impoundment water level does not rise to the extreme tide level. Therefore, the Eel River dam minimizes the impoundment area from the flooding risk resulting from the extreme tide. However, that does not take into consideration other factors that can lead to flooding risk because of the dam, such as ice jams at the control gates of the dam and failure to respond effectively to hydrological events by gate operators (see Section 7.13.4.1.1 Flooding and Flood Risk). With the removal of the dam, the limited protection afforded by the dam with respect to extreme tides will no longer be available.

With the predicted global warming effect, it may be possible for the sea level to rise gradually in the future. According to the Intergovernmental Panel on Climate Change (2001), the global mean sea level could rise 0.09 to 0.88 m by 2100. When both the extreme tide and global warming effect on sea level rise have been considered, the water level in Eel Bay, and hence the estuary below the dam and the impoundment, could rise to an elevation of 3.24 m. This is close to the crest elevation of the dam at 3.4 m, and is significantly higher than the initial design high operating water level of 1.98 m. The rise of mean sea level would increase the risk of tide related flooding in the present impoundment area under the Status Quo and the Project.

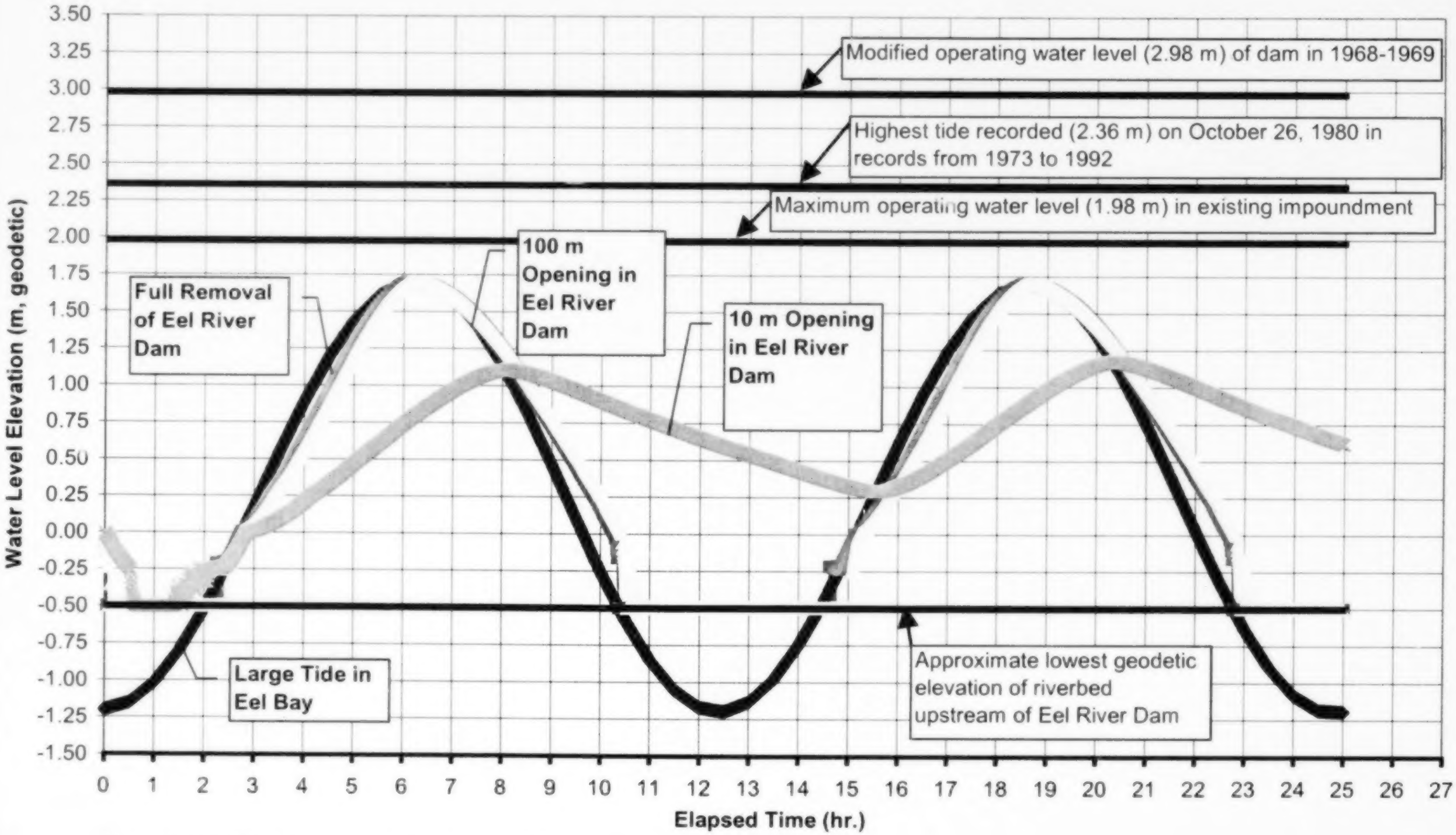
The increase in flooding risk due to climate change is mitigated by the fact that during a modification to the dam in 1968 and 1969, the designed water storage capacity of the impoundment was increased by raising the planned operating level by 1 m to an elevation of 2.98 m. When both extreme sea level rise (0.88 m) and extreme tide conditions (2.36 m) are considered, the maximum water level elevation would be 3.24 m, which is only 0.26 m higher than the planned maximum operating water level in the impoundment. It should also be noted that high water level caused by high tide is short in duration, and would recede with the falling tide, and that the sea level rise estimate is a worse case scenario at the end of the next 100 year period.

Further water level rise is possible due to wind set-up. The magnitude of wind set-up is a function of the fetch length and average depth of the water body. Within the impoundment area, the total fetch length is relatively short, especially in the area of the Village of Eel River Crossing. Therefore, additional water level rise caused by wind set-up within the impoundment and the estuary below the dam is small.

It is therefore conceivable that the area of the impoundment, including the Village of Eel River Crossing, may be subject to additional flooding risk as a result of an extreme tide and potential sea level rise in the future under both the Status Quo and the Project. Detailed topographic and development information for the impoundment area is not available, and thus, a reliable assessment of flooding risk in this area cannot be made.

The substrate elevations and freshwater flow govern the water level in the estuary under low tide conditions. It is expected that during low tide, the channel width along the entire Eel River estuary will be similar to that near the Village of Eel River Crossing. A large portion of the Eel River estuary in the area of the present impoundment will be exposed during periods of low tide and low flow from the land (as it was prior to the construction of the Eel River dam). The proportion of this exposure will increase downstream.

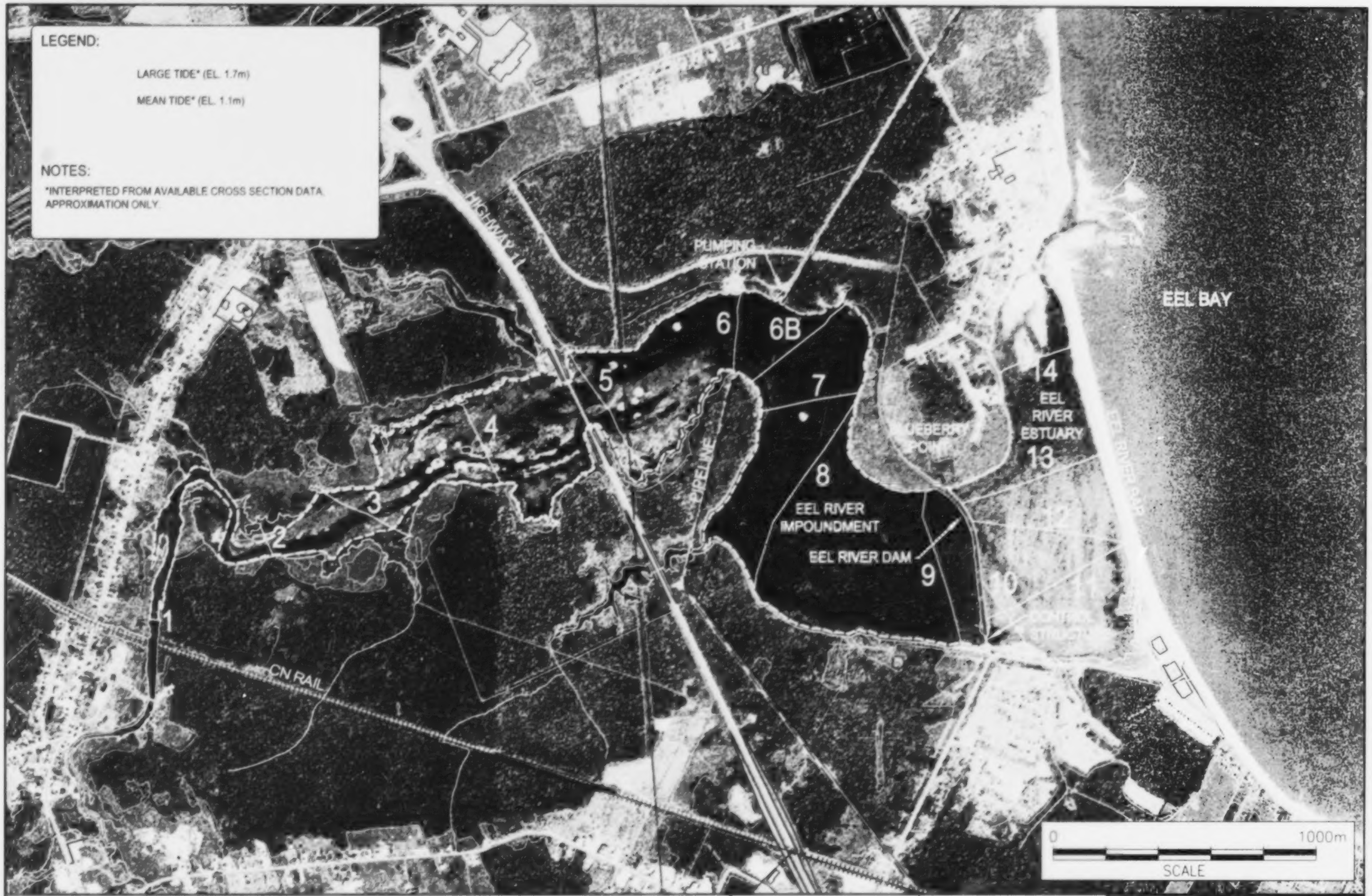
The limit of saltwater intrusion into the estuary is a function of the magnitude of the tide in comparison with the freshwater flow. Under average tide and average freshwater flow conditions, the freshwater and saltwater interface is estimated to be near the Highway 11 Bridge based on the freshwater volume in relation to the total storage in the estuary. An average tide is defined as the average of all tides in a specified 19-year period.



Note: Water level in impoundment below -0.5 m elevation is not simulated

Comparison of Water Level in the Impoundment	Date: 03/31/2006	Scale:	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT
	Job No. 15830	Figure No. **6.1.1**	NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\EIA-TIDES



LEGEND:

LARGE TIDE* (EL. 1.7m)

MEAN TIDE* (EL. 1.1m)

NOTES:

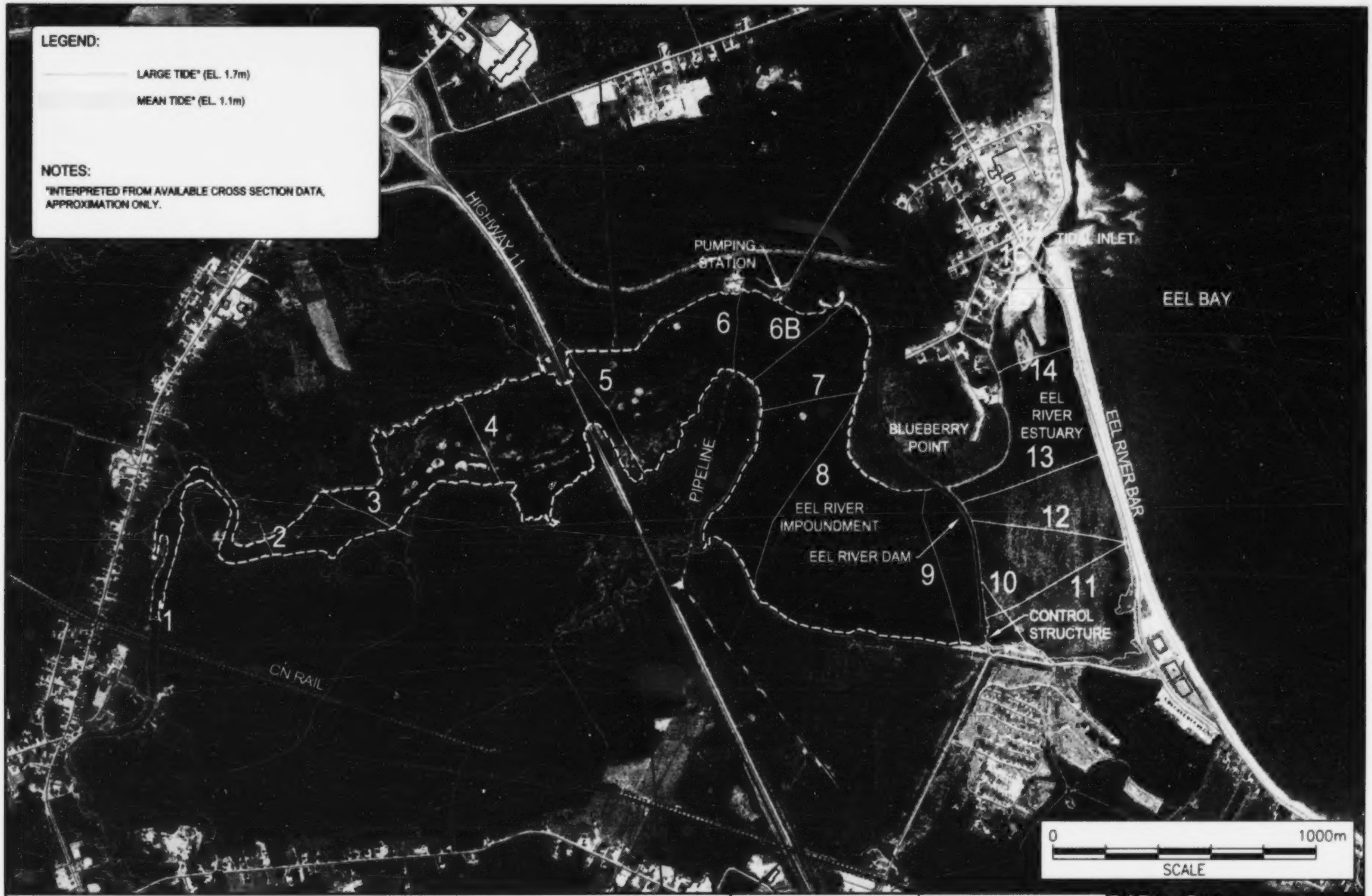
*INTERPRETED FROM AVAILABLE CROSS SECTION DATA. APPROXIMATION ONLY.

HIGHWAY 11
PUMPING STATION
EEL BAY
6
6B
5
7
4
3
2
1
8
9
10
12
13
14
EEL RIVER ESTUARY
BLUEBERRY POINT
EEL RIVER IMPOUNDMENT
EEL RIVER DAM
PIPELINE
CN RAIL
EEL RIVER BAR
CONTROL STRUCTURE
0
1000m
SCALE

HIGH WATER LINE IN THE IMPOUNDMENT FOR LARGE TIDE WITH FULL REMOVAL OF THE EEL RIVER DAM

Date: 2006 03 31	Scale: 1 : 20 000	Eel River Dam
Job No. 15830	Fig. No. 6.1.2	NBDSS PROJECT No. YR101A

FILE: 15830\EIA REPORT\EIA-TIDES


LEGEND:
LARGE TIDE* (EL. 1.7m)
MEAN TIDE* (EL. 1.1m)
NOTES:
*INTERPRETED FROM AVAILABLE CROSS SECTION DATA, APPROXIMATION ONLY.
HIGHWAY 11
PUMPING STATION
TIDAL INLET
15
EEL BAY
6
6B
5
7
4
14
EEL RIVER ESTUARY
EEL RIVER BAR
BLUEBERRY POINT
13
PIPELINE
8
3
2
EEL RIVER IMPOUNDMENT
12
EEL RIVER DAM
9
10
11
CONTROL STRUCTURE
1
CN RAIL
0
1000m
SCALE

HIGH WATER LINE IN THE IMPOUNDMENT FOR LARGE TIDE WITH FULL REMOVAL OF THE EEL RIVER DAM

Date: 2006 03 31

Scale: 1 : 20 000

Job No.: 15830

Fig. No.: 6.1.2

Eel River Dam

NBDSS PROJECT No. YR101A

However, for large tide and low freshwater flow conditions, salt water intrusion is estimated to proceed upstream as far as the railway bridge at the Village of Eel River Crossing. For high spring runoff and low tide conditions, it is possible that no tidal flow will enter the estuary.

The modelling results for an opening width of 100 m have been summarized in Table 6.1.2. Figure 6.1.1 compares the tidal water level variation in the impoundment for this opening width with full removal as simulated with the hydrodynamic model for large tide and mean annual flow. The comparisons are similar for other tide and stream flow scenarios. It is seen from Figure 6.1.1 that, from a hydrodynamic perspective, the 100 m opening width is very similar to the full dam removal. For comparison purposes, the modelling result for an opening width of 10 m is also presented. It is seen that with a 10 m opening only, the water level in the impoundment will be significantly lower than the tidal water level in Eel Bay.

The modelling results indicate that the tidal prism into the Eel River estuary can be adequately restored with an opening width of approximately 100 m.

6.2 Water Quality

6.2.1 Dissolved Oxygen

The water quality data obtained from this study indicate that the DO level in the impoundment is near or above saturation (*i.e.*, the water contained oxygen at a concentration that was near the equilibrium solubility with atmospheric oxygen, given the temperature of the water) during the day time, but experiences a deficit in the early morning of the summer months as a result of algal photosynthesis and community respiration (Section 3.4.1). The DO deficit may improve with time now that the sewage from the Village of Eel River Crossing no longer discharges into Eel River. This is expected to reduce BOD loading and associated oxygen consumption. Algal growth and eutrophic conditions in the impoundment will also be alleviated when nutrient loading into Eel River is reduced, and this should improve the current oxygen deficit presently experienced in the morning of the summer months.

With the full removal of the Eel River dam, eutrophication in the impoundment will be alleviated over time, and the daily fluctuation of DO level characteristic of algal activities will be substantially reduced, due primarily to the enhanced dilution and flushing with marine water. Eventually, the DO levels in the present impoundment area will be close to saturation at all times and will resemble those in the estuary below the dam.

6.2.2 Biochemical Oxygen Demand

With the diversion of sewage from the Village of Eel River Crossing to the Town of Dalhousie wastewater treatment plant in 2005, the sewage effluent from the Village of Balmoral remains as the only significant BOD point source to Eel River (Section 3.4.1). The BOD loading from this point source is currently estimated to be 12.5 kg/day. However, this BOD loading will likely be significantly oxidized prior to reaching Eel River estuary downstream.

The effect of BOD loading on the receiving water quality is affected by the stream flow and tidal flushing. The water quality is typically worst during periods of low stream flow. The mean annual low stream flow for Eel River near the Eel River dam is approximately 0.41 m^3/s. Without considering the BOD oxidation in Eel River upstream of the estuary, the BOD loading rate of 12.5 kg/day combined with mean annual low flow would translate into a consequent BOD concentration of 0.35 mg/L. The actual BOD concentration resulting from this source will be significantly lower due to BOD oxidation upstream of the estuary and tidal flushing. BOD concentration at this level will have a negligible environmental effect on water quality.

With the removal of the Eel River dam, erosion in the impoundment area may occur in the short-term. Erosion may introduce BOD material in the substrate of the estuary into the water column. However, the historical loading rate of BOD material to the impoundment is relatively low, and the BOD material discharged is easily biodegradable. Therefore, the accumulation of BOD material in the substrate of the area of the impoundment is not expected to be great, and this material would rapidly be displaced and degraded in Chaleur Bay.

6.2.3 Nutrients

With the removal of the Eel River dam, the eutrophic conditions (Section 3.4.1) in the impoundment will be improved through increased dilution and flushing. Increased dilution will reduce the nutrient concentration in the impoundment, thereby limiting algal growth. Increased flushing will cause the nutrient to be removed from the estuary more quickly, thereby making it unavailable to algal growth.

Increased dilution will result from the tidal prism migrating upstream into the present impoundment area. Currently, nutrient dilution in the impoundment is provided only by freshwater flow, and the presence of the impoundment results in the nutrients being resident in the impoundment for several days. The re-introduction of tidal flow and drainage into the present impoundment area will provide substantial additional dilution to that provided by freshwater flow, and will substantially reduce the residence time of nutrients in the presently impounded area.

The volume of the tidal prism increases with distance downstream in the estuary, which causes the additional dilution provided by the tidal prism to increase downstream. At the upstream limit of the estuary, the tidal prism will be zero and dilution will remain at the present level. Near the dam and in the estuary below the dam, the additional dilution provided by the tidal prism will be the highest. A summary of the expected dilution as a ratio of the present dilution is presented in Table 6.2.1. Near the dam, the dilution will be increased by a factor of 6.0 for an average tide, and 10.4 for large tide.

The present impoundment provides a travel time in excess of five days for nutrient loading from the watershed, during which time the nutrient will be available for algal growth in the impoundment. With the removal of the dam, this travel time is substantially reduced to approximately 0.5 days, causing a high proportion of the nutrient loading to be flushed to Eel Bay such that it becomes unavailable to algal growth in the area of the impoundment.

Considering the above, it is predicted that with the full removal of Eel River dam, the nutrient concentration in the estuary, particularly the present impoundment area, will be reduced to a level similar to pre-dam conditions.

6.2.4 Salinity

With the removal of the Eel River dam, saline tidal water will migrate into the present impoundment area. For an average tide and average annual flow condition, the saline tidal water will reach approximately the location of the Highway 11 Bridge. For high tide and low stream flow conditions, tidal water can reach the Village of Eel River Crossing, which is estimated to be the approximate upstream tidal limit.

The water quality improvement in the impoundment is primarily affected by the volume of tidal prism migrating into the present impoundment area. For 100 m opening width, the tidal prism migrating into the present impoundment area is similar to that for full dam removal. Therefore, the water quality conditions will be similar to full dam removal discussed in the previous section.

Table 6.2.1 Summary of Increase in Dilution and Reduction in Travel Time in Impoundment as a Result of Dam Removal

Cross Section No.	Tidal Prism to Fresh Water Flow Ratio		Travel Time		
	Mean Tide	Large Tide	Existing Condition (day)	Total Removal (day)	Ratio
1	1.0	1.0	0	0	
2	1.0	1.0	0.1	0.02	0.22
3	1.0	1.0	0.3	0.04	0.12
4	1.0	1.4	0.7	0.05	0.07
5	1.2	2.5	1.3	0.07	0.06
6	1.9	3.8	2.0	0.10	0.05
6B	2.2	4.4	2.3	0.11	0.05
7	2.6	5.1	2.6	0.11	0.04
8	3.5	6.6	3.4	0.13	0.04
9	5.5	9.6	5.0	0.15	0.03
Dam	6.0	10.4	5.4	0.16	0.03

A flow velocity of 0.3 m/s has been assumed for fresh water flow in the calculation of travel time

6.3 Geomorphology

Full removal of the dam will increase the total volume of the tidal water entering and leaving the estuary on each tidal cycle by a factor of 3.6 for a large tide and by a factor of 3.2 for an average tide (Figure 6.3.1). The materials in the bed and banks of the tidal inlet, through the opening in the Eel River bar, are composed of sand and relatively fine gravel. The increased tidal flow will erode this material and re-establish the pre-dam channel with a width of about 90 m at mid-tide elevation. It is expected that the bed of the tidal inlet channel will be lowered by about 0.8 m.

There will probably be a tendency for the former channel on the north side of the estuary, just upstream of the bridge on Route 134, to re-establish itself and become the dominant channel. In such a case, some bank protection will be required in this area.

Most of the erosion in the estuary below the dam is likely to occur in the zone extending about 400 m upstream of the Route 134 bridge that crosses the tidal inlet. Based on pre-dam conditions, this vertical (downward) erosion is estimated to be about 0.5 m. The major changes will probably occur relatively quickly, within 10 years or so, after the removal of the dam.

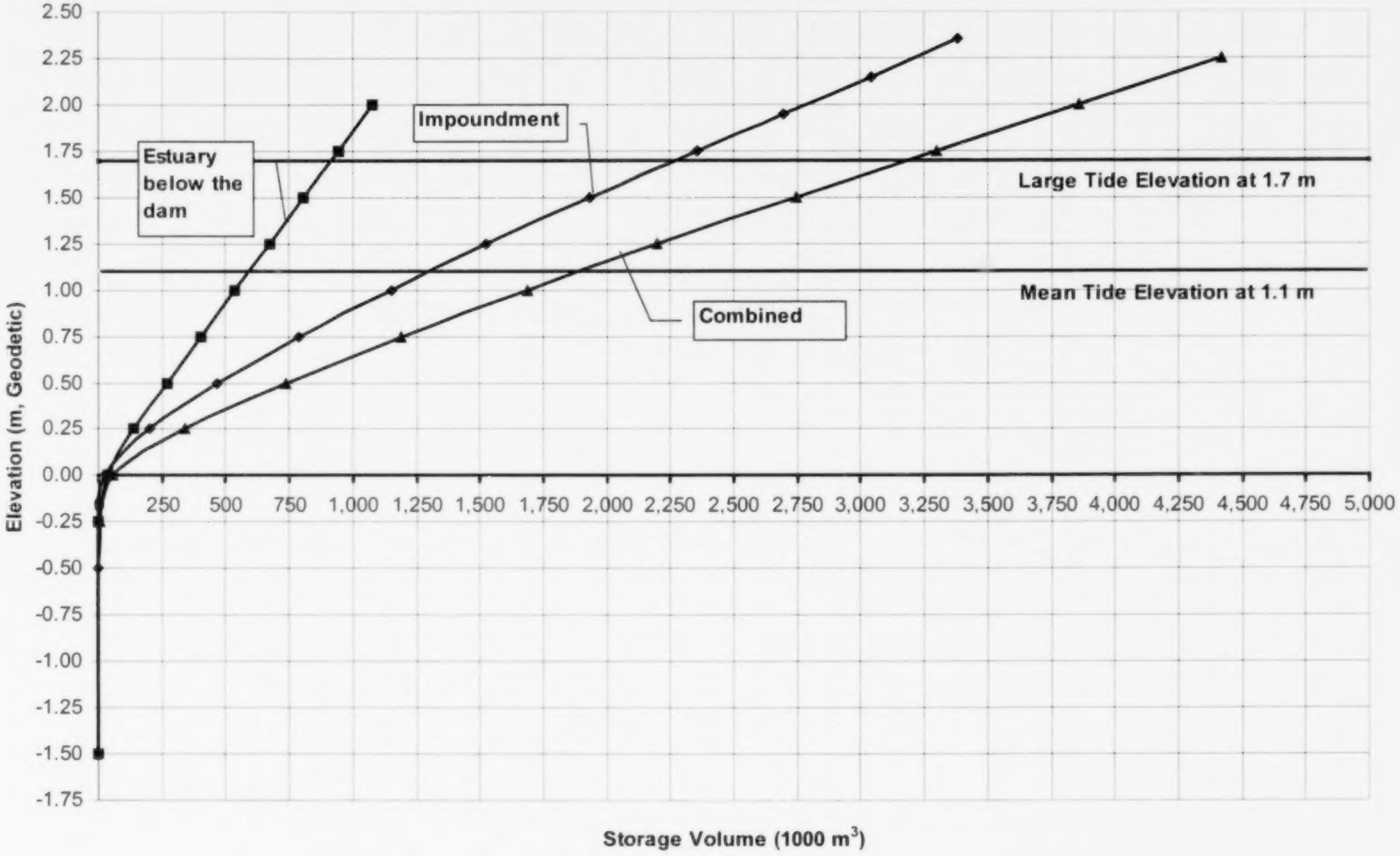
Downstream of the tidal inlet, the channel will also widen to its pre-dam width. One of the channels in the fan-shaped sediment deposit in Eel Bay just downstream of the tidal inlet will likely become more dominant than at present. The channel or channels through the fan-shaped sediment feature may shift from time to time in response to the littoral currents along the coast. Any eroded material from the estuary below the dam or tidal inlet will be temporarily deposited in Eel Bay at the mouth of the channel until the littoral currents resulting from major storms can move it further northward along the coast. These processes are similar to those that occur at the present time.

Upstream of the dam, much of the bed of the estuary will be exposed for at least half of the tidal cycle as it was before the construction of the dam. There should be a tendency for the finer-grained material to deposit at the periphery of the estuary in this area. It is likely that grass will colonize in these areas and form salt marshes that will stabilize the deposited material.

Some of the deposited suspended sediments in the impoundment area could be entrained into the flow during ebb-tide conditions and be transported toward Eel Bay. Most of the erosion of the fine-grained sediments will occur in those zones with relatively high velocities. It is estimated that most of the entrained sediment from the area of the impoundment will move through the estuary below the dam to the tidal inlet and then on to Eel Bay, once it is in transport.

Since the suspended sediment in the salt water entering the estuary from Eel Bay is relatively low, it is not anticipated that the deposition of suspended sediments from the marine side of the Eel River bar will be of major importance over the foreseeable future.

The removal of the dam should not negatively affect the beaches on the Eel Bay side of the Eel River bar since the net littoral currents are directed to the north along the coast in this area. Hence, any sediment that is transported into Eel Bay through the tidal inlet will tend to be transported in a northerly direction.



Elevation and Storage Curves	Date: 03/31/2006	Scale:	Eel River Dam ENVIRONMENTAL IMPACT ASSESSMENT
	Job No. 15830	Figure No. **6.3.1**	NBDSS PROJECT No. YR101A

Provided the section of the dam removed is sufficient to allow a full tidal exchange, with no appreciable delay in timing of the tidal cycle upstream of the dam opening, then the overall conditions will be essentially the same as that for a full removal of the dam. The hydrodynamic modelling demonstrated that a dam opening of 100 m or about one-sixth of the dam width would not significantly modify the tidal regime from that for the case of a full dam removal. The 100 m wide opening in the dam was consistent with order of the anticipated final width to be attained at the tidal inlet.

Depending on the opening width and position in the dam, there will be some localized erosion through the opening and immediately upstream and downstream of the opening. The position of the opening could also have an impact on redevelopment of the channels in the fan-shaped sediment deposit in the Eel River estuary just upstream of the tidal inlet.

An opening on the south end of the dam is likely to direct flow along the Eel River bar to the tidal inlet and as a result reduce the size of the channel on the north side of the Eel River estuary just upstream of the tidal inlet. The ebb-flow currents would attack the bridge piers at an appreciable angle and as a result the area around the piers would have to be monitored for local scour.

An opening on the north end of the dam, where the pre-dam main channel was located (Figure 6.3.1), would promote the redevelopment of the northern channel through the Eel River estuary and into the tidal inlet. If a northern channel were developed, then some bank protection would likely be required along the bank adjacent to this channel. If an opening on the north end of the dam were to be made, then bank protection would be required just upstream and downstream of the opening since there would be strong large scale eddies in these areas.

It seems preferable to make the initial opening near the north end of the dam.

If the dam opening was much smaller than 100 m, then the tidal characteristics will differ from that for a total removal of the dam. The case with an unrealistically small opening of 10 m was illustrated in the hydrodynamic modelling section of the EIA Report (Section 6.1; Figure 6.1.1).

6.4 Ice Regime

The estuary below the dam would still have an ice cover that would move up and down vertically with the tide. Early in the season there would be a “hinge” at the sides of the estuary where the ice meets the banks. As the winter progresses and the ice cover thickens, the hinging effect will become less dominant and the ice will become attached to the bed in those areas where the bed is relatively high. This process will be most apparent during periods with low temperatures during neap tide conditions.

In the area of the impoundment, the ice cover will not be held at the relatively constant level experienced currently. During the early portion of the winter, a relatively thin ice sheet would move up and down. As the season progresses, the ice cover would thicken and the volume of the tidal prism would be appreciably reduced. During periods of low tide, the ice cover would rest on the bed of the channel except for local points in the cross section where the ice cover would float. The ice cover would probably form later and be somewhat thinner because it would be formed from tidal salt water.

The ice forces on the Highway 11 bridge piers currently located in the area of the impoundment should not be appreciably different from those experienced under the present environment.

At the upper end of the estuary, there would be a transition from an estuarine dominated environment to a riverine dominated environment.

The removal of the dam would have no direct effects on the potential for sea ice to pile up on the Eel River bar as a result of the occurrence of a storm surge during the winter. The only anticipated environmental effect is a slight reduction of the time during which ice may block the tidal inlet, because of the greater exchange of water in a wider channel during a tidal cycle.

The results of the Stage 2 opening would be essentially the same as those for removing the entire structure. The reason is that the volume of the tidal exchange is about the same for the two conditions as long as the opening is greater than 100 m. The one point of difference is that the ice around the opening in the dam could be thinner or may not be present with the 100 m opening. The higher velocities in that area would contribute to melt of the ice cover. As a result, an added danger would result from those making use of the ice cover for recreational purposes in the vicinity of the opening in the dam. The narrower the dam opening, the thinner the ice will be in the area of the dam opening. If the velocities were high enough in the area of the dam opening to maintain a local area with no ice cover, then there is a possibility that frazil ice (small ice crystals) would be formed during periods of cold clear nights. The frazil ice would be transported to a site under the ice cover and become deposited there. This process is important in rivers, as it can result in flow blockage and flooding. It would be of importance in this estuarine environment, if frazil ice can form during the Stage 2 dam opening period. If this did occur, it would only be during Stage 2, which is expected to be completed within 1 to 2 years.

7.0 ENVIRONMENTAL EFFECTS ASSESSMENT

7.1 Atmospheric Environment

7.1.1 Rationale for Selection of VEC

The Atmospheric Environment has been selected as a VEC because of its importance to the health and well being of humans and wildlife. The Atmospheric Environment is an important pathway for the transport of air contaminants (including sound), which can result in environmental effects on freshwater, terrestrial and human environments. In the context of this EIA, the Atmospheric Environment will be characterized by Climate, Air Quality, Sound Quality, and Odour. Specifically, the Atmospheric Environment is defined as all physical, biophysical, and chemical attributes of air and climate including, but not limited to, gaseous and particulate emissions, sound, odour, and the natural and anthropogenic (human-made) physical processes that may affect air quality. A complete description of the various aspects of the Atmospheric Environment, including pre-dam, post-dam and existing conditions in the Assessment Area, can be found in Section 3.3.

Key issues of the Atmospheric Environment that will be considered in this assessment include:

- the potential environmental effects of dam removal on the local climate;
- the potential emissions that will contribute to the atmospheric load of greenhouse gas (GHG) emissions and the potential loss or enhancement of carbon dioxide sinks;
- the potential environmental effects of dust generation and exhaust from vehicles/heavy equipment during removal of the dam structure on air quality;
- potential changes to ambient sound pressure levels, including potential sound pressure levels that may occur during removal of the dam structure; and
- the potential for the generation of odour from mudflats and the decomposition of previously submerged vegetation.

7.1.2 Boundaries

The temporal boundaries for the environmental assessment of the Migratory Bird VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The spatial boundaries for the assessment of the potential environmental effects of the Status Quo and Project on the Atmospheric Environment (the "Assessment Area"), with the exception of Climate, consist of the Eel River impoundment and nearby communities of Eel River Crossing, Eel River Bar First Nation (ERBFN), Charlo, Balmoral and Dalhousie, and the surrounding neighbouring communities of the northern Restigouche County coastline. Given the nature of the Project, and that changes in climatic conditions tend to occur on a regional, national and global scale, the spatial boundaries for the assessment of the potential environmental effects of the Project on Climate are defined on a regional scale as Northern New Brunswick, including the Counties of Restigouche and Gloucester.

7.1.3 Threshold for Determination of Significance

7.1.3.1 Climate

Climate variability and climate change are global issues, and the environmental effects of human activities on Climate are difficult to assess on a localized scale. Climate science has not sufficiently advanced to a point where a clear cause and effect relationship can be established between global climate change and local changes to the environment, or even with emissions of GHGs on a local, provincial, or national scale.

While it is acknowledged that the global climate may currently be undergoing measurable changes, and that emissions of GHGs are thought to be a substantive contributor to this global climate change, a cause and effect relationship between climate change and the Status Quo or Project would be difficult to establish because of the nominal changes related to the Project as compared to global emissions. Some localized variations in microclimate in specific areas in the immediate vicinity of Eel River may result from the Status Quo or Project, but these changes would not be distinguishable, with some certainty, on a regional or even provincial or national scale, due to the relatively limited scale of the Status Quo or Project in the global context.

In this light, and in the absence of specific regulatory guidance on carbon dioxide (CO_2) emissions or climate change, a *significant negative residual environmental effect* on Climate is considered to be one that results in a substantive increase to provincial releases of GHGs (*i.e.*, >1% of total provincial CO_2 emissions), or a substantial loss in carbon sinks (*i.e.*, >1% of carbon sinks) in Northern New Brunswick. These are conservatively set thresholds, as climate variability and climate change is a global phenomenon to which New Brunswick is, relatively speaking, a very small contributor in the context of national and global emissions.

7.1.3.2 Air Quality

A *significant negative residual environmental effect* on Air Quality is considered to be one that degrades the quality of the air to such an extent that the emissions of the air contaminants of concern lead to an exceedance of the ambient air quality standards, as defined in the New Brunswick *Air Quality Regulation – Clean Air Act*. For the purposes of this assessment, the air contaminants of concern are considered to be as total particulate matter (TPM), sulphur dioxide (SO_2), nitrogen oxides (NO_x as NO_2), carbon monoxide (CO), and hydrogen sulphide (H_2S). These regulatory standards have been established to be conservatively protective of air quality, human health and the environment, and thus the criterion is similarly considered protective.

7.1.3.3 Sound Quality

A *significant negative residual environmental effect* on Sound Quality is considered to be one that creates a "nuisance" at the nearest residential property boundary by causing a frequent exceedance (*i.e.*, more than 10 percent of the time on an annual basis) of the noise guideline level, on a sustained and permanent basis, at the nearest noise sensitive area (NSA). In the absence of official regulatory guidelines in New Brunswick for acceptable ambient sound pressure levels, the current New Brunswick Department of Transportation (NBDOT) threshold value of 65 dBA measured as a 24-hour Leq (used for highway construction projects) will be used as the noise guideline level (ADI, 2003).

In areas where the baseline (2005) ambient sound pressure levels already exceed the NBDOT noise guideline level, a significant negative residual environmental effect on Sound Quality is one that creates a "nuisance" at the nearest residential property boundary by frequently causing a substantive increase in ambient sound pressure levels (*i.e.*, >10 dBA above background), measured as a 24-hour Leq.

7.1.3.4 Odour

A *significant negative residual environmental effect* on Odour is considered to be one that results in a noticeable change in the character, intensity or frequency of odours in the Assessment Area, such that the resulting odours would frequently (*i.e.*, >10 percent of the time on an annual basis) and substantially interfere with the normal conduct of business, or the normal enjoyment of the use of properties by a group of people (*e.g.*, residents of a subdivision adjacent to the source), as defined in Section 6(2) of the New Brunswick *Clean Air Act*.

7.1.4 Evaluation of Potential Environmental Effects

7.1.4.1 Status Quo

7.1.4.1.1 Climate

As discussed in Section 3.3, the general climate trends in Northern New Brunswick, including the Assessment Area, are long-term characteristics and therefore are not expected to change substantively from pre-dam to existing conditions. Considering the relatively low density of existing industry in the area, GHG emissions for the Assessment Area are relatively low, accounting for approximately 5 percent of Provincial GHG emissions. It is likely that some of the emissions are offset by the topographical features of the area, such as the extensive forest cover, which serve as carbon sinks.

Other than natural climate variations that may occur in the Assessment Area, as well as the potential environmental effects of global climate changes on the local and regional climate in the Assessment Area, no measurable change to Climate is expected from the Status Quo. There are no aspects of the Status Quo that would result in substantive changes to GHG emissions, regional climate, or microclimate in the Assessment Area.

Given the long-term characteristics of climate trends and influences in the Assessment Area (and in Northern New Brunswick in general), and the absence of elements of the Status Quo that would be expected to result in measurable changes to climate on a local or regional scale, the environmental effects of the Status Quo on Climate are rated not significant.

7.1.4.1.2 Air Quality

From the limited information available on emissions data for the area, the air quality in the Assessment Area is considered to be relatively good. As discussed in Section 3.3, compliance with the applicable Canadian and New Brunswick Ambient Air Quality Standards was 100 percent for the Assessment Area, with no exceedences of these standards reported for any monitoring year. Further, the overall contribution of emissions from sources in the Assessment Area to ambient concentrations of air contaminant emissions in the Province of New Brunswick is minimal.

The Status Quo is not expected to result in any measurable changes to emissions or ambient air quality on a local or regional scale. Emissions and ambient air quality concentrations on a local and regional basis may vary from year to year and be affected by a variety of factors that are difficult to predict (*e.g.*, long-range transport of air contaminant emissions). In general, it is hard to predict what changes to air quality would be expected to occur in the Assessment Area under the Status Quo. However, any changes to air quality in the Assessment Area would likely be attributable to other factors rather than the Status Quo directly, and the potential environmental effects from these other factors would far outweigh any issues that may arise directly as a result of the Status Quo.

Given the current state of air quality in the Assessment Area, and the absence of elements of the Status Quo that would be expected to result in measurable changes to emissions or ambient air quality on a local or regional scale, the environmental effects of the Status Quo on Air Quality are rated not significant.

7.1.4.1.3 Sound Quality

As discussed in Section 3.3, no published data on sound quality in the Assessment Area could be located for pre-dam or existing conditions. However, the existing sound pressure levels are expected to be relatively low and typical of a rural environment, given the lower population and topographical features of the area. There are no aspects of the Status Quo that are expected to result in any measurable changes to existing sound pressure levels in the Assessment Area.

Given the current state of sound quality in the Assessment Area, and the absence of elements of the Status Quo that would be expected to result in measurable changes to sound quality in the Assessment Area, the environmental effects of the Status Quo on Sound Quality are rated not significant.

7.1.4.1.4 Odour

As discussed in Section 3.3, no published data on odours in the Assessment Area could be located for pre-dam or existing conditions. No odour emissions were reported by any members of the Water Quality Field Study Team during any of the fieldwork conducted in the impoundment area, including during the period of low water level in the impoundment in August 2005 when bottom areas of the impoundment were exposed. One resident of the Village of Eel River Crossing, whose house is situated along Eel River near the former sewage lagoon outfall, reported an unpleasant odour occurring on a regular basis near their property. Since the Village of Eel River Crossing was connected to the Town of Dalhousie sewage treatment system in June 2005, the resident has reported an improvement in the odour emissions. It is expected that the odour emissions near this resident's home would continue to improve under the Status Quo, particularly with the flushing of the impoundment that will occur with the spring freshet over the next couple of years.

The decomposition of organic matter, either as a result of submerged vegetation or increased nutrient loadings leading to algal blooms (*i.e.*, eutrophication), has the potential to result in odours from decay processes. This typically occurs in an anaerobic environment (*i.e.*, in the absence of oxygen). A small amount of submerged vegetation is present in the impoundment, but the amount does not seem to be great enough to cause substantive negative odour emissions. The potential for odour issues arising from increased nutrient loadings has been greatly reduced by the deactivation of the former sewage lagoon outfall.

During the period of low water level in August 2005, much of the bottom of the impoundment was exposed. Members of the Field Study Team noted that the bottom is largely comprised of sandy, silty or clay sediment, which does not tend to have an odour, in contrast to the organic-rich beds of ponds, bogs, wetlands, and some lakes, which tend to have a characteristic mudflat-like odour. In the event of similar extreme periods of low water level in the impoundment under the Status Quo in the future, therefore, it is not expected that episodes of offensive odour emissions would be produced for extended periods of time.

Current levels of submerged vegetation and nutrient loadings, along with the type of sediment at the bottom of the impoundment, do not seem to be causing any substantive negative odour emissions, nor are they expected to cause such emissions in the future. In addition, previous reports of negative odour emissions in the impoundment seem to have been largely related to the former sewage lagoon outfall, which has since been deactivated and subsequently resulted in improved conditions. Therefore, the environmental effects of the Status Quo on Odour are rated not significant.

7.1.4.2 The Project

7.1.4.2.1 Climate

The Project is expected to result in the release of some GHG emissions from the operation of vehicles/heavy equipment during the placement of the turbidity/sediment control and rockfill barriers, and the actual removal of the dam (Stage 2 and Stage 3). However, these emissions would be temporary, intermittent, of short duration and confined to a local area, and should not be discernible from current levels of GHG emissions at a local or regional scale. Additional discussion on combustion emissions is provided in Section 7.1.4.2.2 below.

Some physical changes to the local landscape will occur as a result of the Project, which have the potential to affect local weather patterns and subsequently the microclimate of the area. Measurable regional or global climate change is not expected to occur as a result of the Project, and therefore will not be considered further. Also, any small-scale changes in the characteristics of the Eel River estuary or Eel Bay that may occur downstream of the current dam location are unlikely to be measurable compared to current climate conditions, and will not be considered further. The assessment will therefore focus on the potential environmental effects of the Project on microclimate upstream of the current dam location.

The current impoundment would be replaced by a narrow river channel, which would restore the free-flow of tidal waters twice daily upstream of the current dam location. The ground surface has a lower albedo (*i.e.*, a lesser ability to reflect sunlight) compared to water. During periods of low tide throughout the day, when the bottom of the current impoundment would be exposed, the ground surface would reflect less sunlight than what is presently the case for the water in the impoundment. More heat would be absorbed by the ground surface, resulting in net radiative cooling to the air near the ground surface. At high tide, these conditions would remain unchanged from the Status Quo. During periods of low tide at night, the heat that had been absorbed by the ground surface during the day would be released, warming the air near the ground surface, and resulting in net radiative heating.

The interaction of hot and cold air molecules as a result of these changes in albedo could produce small changes in surface turbulence and subsequently influence winds at a localized scale. Any environmental effects to local weather parameters such as temperature and winds would be on a microclimatic scale and not likely discernible from current conditions beyond the immediate vicinity of the current impoundment. The frequency of this phenomenon would be intermittent, as it would tend to be greatest on sunny days where peaks in incident solar radiation (sunny days, mid-day) coincided with low tide. Since most weather variables did not change appreciably from pre-dam to existing conditions, the potential changes in microclimate due to the albedo of the exposed ground surface in the current impoundment area as a result of the Project are likely to be infrequent, small and localized. The environmental effects of the Project on Climate due to changes in the absorption of radiant heat are therefore rated not significant.

The impoundment presently consists of freshwater and thus freezes over during the winter. The Project would result in saltwater conditions (or a mix of saltwater and freshwater) in the current impoundment area, and thus the water in the current impoundment area would be expected to freeze later, intermittently or not at all, during the winter. Because of their salinity, the tidal waters (originating from the Chaleur Bay) could be slightly warmer during the winter and slightly cooler during the summer than the water contained in the current impoundment area, thus resulting in little (or later) freezing of the water in the current impoundment area. Also, the water temperature in the Chaleur Bay may be slightly warmer than the water currently in the impoundment in the winter and slightly cooler in the summer. This could lead to small, localized changes in ambient temperature and surface turbulence in the immediate vicinity of the current impoundment area in the winter. Again, from a microclimatic standpoint, since most weather variables did not change appreciably from pre-dam to existing conditions, the potential changes in microclimate from the altered water temperatures in the current impoundment area as a result of the Project are not expected be substantial. Therefore, the environmental effects of the Project on Climate due to change in the formation of ice are rated not significant.

There are no aspects of the Project that are expected to result in changes to the current atmospheric processes over the Chaleur Bay or Eel Bay that would lead to the formation of marine advection fog. Subsequently, there are no expected changes to regional air masses that would result in increased or decreased incidence of fog carried up-river from the Eel Bay. However, fog could form when tidal (cooler) waters come into contact with the warmer ground surface around the estuary, but any such fog would not be expected to extend much beyond the immediate vicinity of the impoundment area. The frequency, duration, and extent of such events would likely be similar to pre-dam conditions. Climate data from the Charlo Airport meteorological station indicates that the region already experiences fog, on average, 52 days per year (defined by Environment Canada as having at least one hour these days experiencing fog conditions). Any fog that forms as a result of the Project would likely be localized, intermittent, of short duration (*e.g.*, a few hours), and similar to natural pre-dam conditions. Therefore, the environmental effects of the Project on Climate due to changes in fog conditions are rated not significant.

Carbon sinks are areas where carbon is removed from the CO_2 in the atmosphere and is concentrated in a non-gaseous form such as occurring in wetland plants, and more substantively in forests; the breakdown of organic matter by biological organisms (*e.g.*, bacteria); and by absorption in saltwater. It is believed that carbon sinks are essential to help limit climate change caused by excess CO_2 in the atmosphere. Wetlands and other vegetation serve as carbon sinks by absorbing carbon dioxide from the atmosphere.

The Project may result in the loss of carbon sinks in some parts of the Assessment Area, but the enhancement or creation of carbon sinks in others. As discussed in Section 7.3.4.2, the amount of freshwater marsh habitat in the current impoundment area would be greatly reduced as a result of the influx of saltwater associated with tidal flushing, but this loss would be offset by the production of saltmarsh habitat in a large portion of the estuary. The small amount of saltmarsh below the location of the dam may or may not be reduced. Overall, any losses of wetlands or saltmarshes would be relatively small on a regional or provincial scale, and likely offset by the enhancement or creation of new saltmarsh habitat. Therefore, it is not expected that the Project would result in any substantive losses in carbon sinks in the Assessment Area, and to an even lesser extent as measured on a regional or global scale. Therefore, the environmental effects of the Project on Climate due to changes in GHG sinks are rated not significant.

In summary, while there may be some localized changes that occur to the microclimate in the Assessment Area as a result of the Project, the potential negative environmental effects of the Project on Climate overall are rated not significant on local, regional, provincial, national and global scales.

7.1.4.2.2 Air Quality

The Project is expected to result in the release of some air contaminant emissions in the form of combustion gases and particulate matter from the operation of vehicles/heavy equipment during the placement of the turbidity/sediment control and rockfill barriers, and the actual removal of the dam (Stage 2 and Stage 3). However, these emissions would be temporary, intermittent, of short duration and confined to a local area, and should not be discernible from current emission levels on a local or regional scale. Ambient air quality in the Assessment Area would remain well below the Canadian and New Brunswick Ambient Air Quality Standards. Standard mitigation measures (*e.g.*, following federal and provincial guidelines and regulations, using dust suppressants, and ensuring proper maintenance of equipment) would be used to minimize the potential environmental effects to air quality from the operation of vehicles/heavy equipment.

Overall, there could be very small amounts of fugitive particulate matter (dust) generated from the placement of turbidity and sediment control structures and rockfill barriers, and the actual removal of the dam (Stage 2 and Stage 3). Any dust generated would be temporary, of short duration, and generally limited to the immediate vicinity of the physical work. Ambient air quality in the Assessment Area would not be expected to result in frequent exceedances of the Canadian and New Brunswick Ambient Air Quality Standards.

Overall, given the current state of air quality in the Assessment Area, the nature of the emissions associated with the Project (*i.e.*, minimal, temporary, intermittent, of short duration, and confined to a local area), and the mitigation proposed, the environmental effects of the Project on Air Quality are rated not significant.

7.1.4.2.3 Sound Quality

The Project is expected to result in sound from the operation of vehicles/heavy equipment during the placement of the turbidity/sediment control and rockfill barriers, and the actual removal of the dam (Stage 2 and Stage 3). The type of sound produced during these activities may involve sound from motorized equipment, backup beepers, tailgate slamming, and excavation. Sounds generated from the friction of tires on roadways during wet weather may occur. The environmental effects of noise (unwanted sound) may vary depending on the number and location of NSAs (*e.g.*, residential properties, schools, hospitals), and other factors affecting noise transmission (*e.g.*, vegetation, topography, meteorological weather conditions).

Any sound as a result of these activities would be temporary, intermittent, of short duration, and confined to a local area immediately surrounding the area where the physical work is taking place. There are few residential receptors or NSAs in close proximity to the dam, where most of the physical work would be carried out. There may be short-term incidences of elevated sound pressure (*i.e.*, peaks). However, the vehicles/heavy equipment would be constantly moving around and would not always be at the nearest point to any particular residence. Therefore, the resulting sound pressure levels are not expected to frequently cause an increase of 10 dBA (based on a 24-hour Leq) above existing background levels or exceed 65 dBA (based on a 24-hour Leq) in areas for which existing sound quality is within these levels. Standard mitigation measures (*e.g.*, using mufflers, ensuring proper maintenance of equipment, and restricting activities to daytime hours, where warranted) would be used to minimize the potential environmental effects to Sound Quality from the operation of vehicles/heavy equipment.

Overall, given the current state of sound quality in the Assessment Area, the type and extent of sound associated with the Project (*i.e.*, temporary, intermittent, of short duration, and confined to a local area), and the mitigation proposed, the environmental effects of the Project on Sound Quality are rated not significant.

7.1.4.2.4 Odour

The Project is expected to result in certain parts of the bottom of the current impoundment being exposed during low tide (possibly similar to the situation encountered during the period of low water level in August 2005). As discussed in Section 7.1.4.1.4, it is unlikely that this exposure will result in odour emissions that could cause negative environmental effects because the sediment that was observed on the bottom of the impoundment during the low water level event is not the type that tends to produce odour emissions. No odour emissions were detected by members of the Water Quality Field Study Team during the low water event. Further, should the deposit of any organic-rich sediment or other odour-producing substances occur, it is expected that the twice-daily tidal action would flush these substances out into Eel Bay and beyond before any substantive accumulation of such sediments could occur.

It is also unlikely that any exposed vegetation during low tide would cause odour emissions that would result in substantial or frequent negative environment effects, as there is not an appreciable amount of vegetation in the impoundment. Currently, the limited amount of submerged vegetation in the impoundment, where it exists, does not seem to be producing any detectable or offensive odour emissions, nor were any odour emissions detected by members of the Jacques Whitford Study Team when the vegetation was exposed during the low water event in August 2005. It is expected that tidal flushing would reduce the potential for negative odour emissions.

It is expected that the Project will remediate any lingering odour emissions related to the former sewage lagoon outfall at the upper end of the impoundment, due to the restoration of the free-flow in Eel River and the tidal flushing of the current impoundment twice daily.

Overall, given the type of sediment at the bottom of the impoundment, the restoration of flow in Eel River and tidal flushing in the current impoundment area, and the mitigation proposed, the environmental effects of the Project on Odour are rated not significant to positive.

7.1.5 Accidents, Malfunctions and Unplanned Events

In the Jacques Whitford Study Team's professional judgment, there are no foreseeable features of the Status Quo or Project that would result in accidents, malfunctions or unplanned events that would lead to a significant negative environmental effect to the Atmospheric Environment, including Climate, Air Quality, Sound Quality, and Odour. Any accidents, malfunctions or unplanned events that may occur as a result of the Status Quo or Project would likely be corrected by initiating immediate actions, or implementing mitigation, to cease, control, or prevent a reoccurrence of these events (*e.g.*, unplanned noise events due to faulty noise abatement on construction equipment). These actions and mitigation measures would likely consist of conventional techniques to prevent or remediate the potential environmental effect.

Therefore, the potential environmental effects of Accidents, Malfunctions and Unplanned Events, for both the Status Quo and the Project, are rated not significant.

7.2 Fish Habitat and Fish

7.2.1 Rationale for Selection of VEC

Two of the Project Objectives are to achieve a long-term solution to fish passage, and improvement of habitat for softshelled clams and other shellfish upstream and downstream of the Eel River dam (Section 1.1.3). Fish Habitat and Fish was selected as a VEC because of its inherent relevance to these objectives. Key issues relating to Fish Habitat include the fishway structure and associated fish passage concerns, water quality, and sediment quality.

7.2.2 Boundaries

The temporal boundaries for the environmental assessment of the Fish Habitat and Fish VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The spatial boundaries (*i.e.*, Assessment Area) of the Fish Habitat and Fish VEC include the waters upstream and downstream of the Eel River dam that may be affected by the Project, from the dam to the upper end of the impoundment and from the dam to the marine environment proximal to the tidal inlet in Eel Bay.

7.2.3 Threshold for Determination of Significance

7.2.3.1 Fish Habitat

"Fish Habitat" is defined under the *Fisheries Act* as spawning, rearing, nursery, food supply, overwintering, migration corridors, and any other area on which fish depend directly or indirectly in order to carry out their life processes.

A *significant negative residual environmental effect* on Fish Habitat is considered to be one that results in:

- a non-compensated harmful alteration, disruption or destruction (HADD) of the spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes (as determined by DFO per Section 35(2) of the *Fisheries Act*); and/or
- the concentration of specific water quality parameters exceeding the Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life; and/or
- the concentration of specific sediment quality parameters exceeding background concentrations and the CCME sediment Probable Effect Levels (PEL) on Aquatic Life, for a sufficient period of time and over a sufficient area that an exceedance of the significance criteria for Fish may occur.

7.2.3.2 Fish

"Fish" is defined under the *Fisheries Act* as fish, shellfish, crustaceans, marine animals, and any parts of fish, shellfish, crustaceans, or marine animals, and the eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals.

A *significant negative residual environmental effect* on Fish is considered to be one that affects Fish (*e.g.*, direct mortality, change in migratory patterns, habitat avoidance) in such a way as to cause a decline in abundance, or an undesirable increase in the population or change in distribution of common and secure species, of indicator/representative species over one or more generations within the regional population, and natural recruitment may not re-establish the population(s) to its original level.

No Fish Species of Conservation Concern or Species at Risk are known to inhabit the Assessment Area, and therefore they will not be considered further in this EIA.

7.2.4 Evaluation of Potential Environmental Effects

7.2.4.1 Status Quo

7.2.4.1.1 Fish Habitat

The fishway structure is currently an impediment to certain species of migratory fish (*e.g.*, smelts, Atlantic tomcod). As discussed in Chapter 4, modifying the fishway structure would improve fish passage for some species at some times, but would not effectively achieve the fish passage Project Objective of providing for the unimpeded and safe movement, upstream or downstream, of all fish between aquatic habitats required to complete their life cycle. Some species would continue to have physical difficulty getting over the dam, and all species would still be exposed to marked changes in temperature and salinity upstream of the dam (see below) and increased predation below the dam. As well, the presence of ice during the winter months could affect the operation of the fishway, thus limiting the upstream and downstream movement of fish species, primarily Atlantic tomcod.

Regarding water quality, currently the Eel River impoundment is comprised almost entirely of freshwater with low salinity. As discussed in Section 3.4.1, eutrophic conditions exist in the impoundment, consisting of relatively high concentrations of available nutrients, warm water temperatures, and depressed night-time oxygen concentrations during the summer months. The combination of an abrupt transition from near-marine salinity to freshwater, together with high water temperatures and periodic low dissolved oxygen (DO) concentrations, could be stressful or limiting to migratory fish, particularly salmonids.

Sediments within the impoundment contain more silt and ammonia than sediments in the estuary below the dam, consistent with the quiescent nature of the water body, and its eutrophic condition (Section 3.4.2). However, concentrations of heavy metals and persistent organic pollutants are low, indicating that there has been no substantive introduction of chemical pollutants, other than nutrients, to the system. There are no longer any softshell clams in the impoundment due to the freshwater environment. The coarser sediment that has developed downstream of the dam since its construction provides less suitable clam habitat than the finer sediements that existed prior to construction (Medcof, 1967), and subsequently the abundance of clams has decreased in this area.

In summary, the fishway structure will continue to be an impediment to fish passage, and thus the fish passage Project Objective will not be achieved under the Status Quo. Water quality issues will persist in the impoundment, including the abrupt transition from near marine salinity to freshwater conditions, high water temperatures, and the eutrophic conditions resulting in low DO concentrations, all of which are problematic for fish. Sediment quality issues involving grain size and lack of suitable clam habitat below the dam will also persist, meaning softshelled clam stocks below the dam may decline further and the Project Objective of improving habitat for these clams and other shellfish will not be achieved. For all of these reasons, therefore, the Status Quo will continue to result in significant environmental effects on Fish Habitat.

7.2.4.1.2 Fish

Under the Status Quo, the fishway will continue to prevent native anadromous fish species (*e.g.*, rainbow smelts, Atlantic salmon) from accessing the Eel River for life cycle purposes. Further, softshelled clams and other shellfish will remain absent from the current impoundment area due to its freshwater condition, and limited in the estuary below the dam due to the unsuitable habitat provided by the coarser sediments in this area. Therefore, the Status Quo will continue to result in significant environmental effects on Fish.

7.2.4.2 The Project

7.2.4.2.1 Fish Habitat

Given that the Project itself is aimed at the effective removal of the Eel River dam to achieve the fish passage Project Objective, the fish passage concern will be rectified as a result of the Project.

The Project will result in the restoration of the free-flow of tidal waters and subsequently saltwater conditions (or a mix of saltwater and freshwater) in the current Eel River impoundment area. As such, there will be opportunity for a natural transition between the freshwater and marine environments for migratory fish. In addition, the restored tidal flow will flush nutrients from the current impoundment area out to Eel Bay, and prevent eutrophication (and low DO concentrations) from occurring in the future. The water will also be cooler in the summer due to reduced residential time of water in the current impoundment area and the introduction of cooler tidal waters from the Chaleur Bay. The current water quality concerns will be rectified as a result of the Project.

Regarding sediment quality, the Project is expected to result in the restoration of tidal mudflats in the Assessment Area, particularly upstream of the dam, similar to pre-dam conditions. The mudflat habitat combined with the estuarine conditions will provide the opportunity for softshelled clam stocks to re-establish.

Immediately following the removal of the dam, flushing of sediments that have accumulated in the Eel River and current impoundment area since the construction of the dam is expected to occur. However, some flushing of sediments from these areas has occurred over the life of the dam when the gates have been opened during spring runoff and high rainfall events. As such, the accumulation of any substantial amount of sediments upstream of the dam has been prevented, and relatively little sediment will be released to the downstream estuary and Eel Bay following the removal of the dam. It is therefore anticipated that any negative environmental effects from the release of sediments to the water column and on fish habitat will be short in duration (*i.e.*, a few months), and not expected to result in significant environmental effects. Further, the sediment that is released from the upper portion of the presently impounded area will help to replenish the fine sediment fraction to sediments located in the estuary below the dam, similar to pre-dam conditions. This will help to create conditions favourable for clam stocks to replenish below the dam as well. Therefore, the Project Objective of improving habitat for softshelled clams and other shellfish upstream and downstream of the dam will be achieved.

In summary, the Project by nature will rectify the fish passage concern, and thus the fish passage Project Objective will be achieved. Water quality concerns including the abrupt saltwater-freshwater transition and eutrophication in the current impoundment area will also be rectified as a result of the Project, through the restoration of the free-flow of tidal waters and twice daily flushing of the current impoundment area. Sediment quality issues involving grain size and lack of suitable softshelled clam habitat will be rectified with the return of mudflats similar to pre-dam conditions, and clam stocks will have the opportunity to replenish. As such, the Project Objective of improving habitat for softshelled clams and other shellfish will be met. There are no expected conditions that would lead to the impairment of water or sediment quality with respect to the CCME guidelines. The release of accumulated sediments to the current Eel River estuary and Eel Bay as a result of the Project is not expected to be substantial, and any environmental effects will be short in duration and are predicted to be not significant. Overall, the Project will result in positive environment effects on Fish Habitat.

7.2.4.2.2 Fish

The Project will restore the ability for diadromous fish to move freely between the Eel River headwaters and the Chaleurs Bay and beyond. This will provide the opportunity for the restoraton of the diadromous fish that use Eel River for spawning or rearing purposes, specifically: the American eel; American shad; Atlantic salmon; Atlantic tomcod; gaspereau; rainbow smelt; sea-run brook trout; and sea lamprey. The Project will result in the alteration of fish habitat in the current impoundment area, as the primarily freshwater conditions will become estuarine with the restoration of the free-flow of tidal waters. While there will be a loss of freshwater fish in the impoundment, these species will be replaced by those that prefer estuarine environments. There will be no net loss of fish habitat as a result of the Project, only a change and restoration in the type of habitat and species present in the current impoundment area. The restored estuarine habitat and associated species composition is expected to be similar to pre-dam conditions, and may improve regional biodiversity. Overall, the Project is predicted to have a positive environmental effect on fish in the Assessment Area.

The restoration of estuarine conditions in the current impoundment area and mudflat habitat in much of the Assessment Area will provide the opportunity for the replenishment of softshelled clam stocks. As such, the Project is predicted to have a positive environmental effect on clams in the Assessment Area.

Given the restoration of native estuarine fish species and clams to the Assessment Area, and the restoration of free passage for anadromous and diadromous fish species, overall the Project will result in positive environment effects on Fish.

7.2.5 Accidents, Malfunctions and Unplanned Events

In the Jacques Whitford Study Team's professional judgment, there are no foreseeable features of the Status Quo that would result in accidents, malfunctions or unplanned events that would lead to a significant environmental effect on Fish Habitat and Fish. There is a possibility that hazardous materials used during Project activities could be accidentally spilled and introduced into the Eel River. These materials could temporarily degrade water and sediment quality and fish habitat, and directly kill fish. However, mitigation measures as outlined in the EMP (Section 5.4) will protect against such spills and provide for their safe and effective clean up. For example, there will be a separate laydown area and refuelling station away from the river for construction vehicles and equipment.

Based on consideration of the potential environmental effects, the proposed mitigation and the residual environmental effects significance rating criteria, the potential environmental effects of Accidents, Malfunctions and Unplanned Events on Fish Habitat and Fish, for both the Status Quo and the Project, are rated not significant.

7.3 Terrestrial Environment

Terrestrial Environment is a VEC that comprises several components including Wetland and Vegetation, Wildlife, and Species of Special Conservation Concern, associated with these.

7.3.1 Rationale for Selection of VEC

The rationale for selecting the sub-components of the Terrestrial Environment VEC is presented in the following sections.

7.3.1.1 Wetland and Vegetation

Wetland and Vegetation are of ecological importance in the Assessment Area. There will be substantial changes in wetland type and area, and vegetation (wetland and riparian) due to Project activities, which may alter wetland functions and habitat for Species of Conservation Concern both upstream and downstream of the dam.

There is both a Federal Policy on Wetland Conservation and a NB Wetlands Conservation Policy. The focal purpose of both these policies is the sustainable management of wetland resources (both for wildlife and humans) and is underpinned by a commitment to "no net loss of wetland function". The "no net loss" principal requires any such loss to be compensated, ideally through provision of similar wetland function at the same location. This may be accomplished by restoration/enhancement of degraded or low function wetland at the site or support of wetland restoration activities in the surrounding region.

Plant Species of Conservation Concern in wetland and riparian areas are considered to have some level of risk but are not Species at Risk under the protection of *SARA* or the New Brunswick *Endangered Species Act*. Some, however, may receive specific protection described in a management plan developed as a result of Section 65 of *SARA*. Species at Risk are addressed in Section 7.5. Negative environmental effects on these species may result in their becoming threatened or endangered; therefore, potential environmental effects from the Project must be considered. Species of Conservation Concern have been included in the consideration of environmental effects on wetland and riparian vegetation because a change to their habitat (not individuals) is the key concern.

7.3.1.2 Wildlife

Wildlife has been selected as a sub-component of the Terrestrial Environment VEC because wildlife habitats are known to occur in the potential zone of influence of the Status Quo and the Project. Wildlife may be subject to changes in wildlife habitat type, quantity and/or quality, both upstream and downstream of the dam. Upstream of the dam, the Project will change the freshwater environment to an estuarine environment and may alter wetland and shoreline habitat quality and quantity for wildlife. Downstream of the dam, wildlife habitat may be altered or changed in quality (*e.g.*, due to changes in channel width, depth, hydrodynamics and sediment transport).

Wildlife Species of Conservation Concern are considered to have some level of risk but are not under the protection of *SARA* or the New Brunswick *Endangered Species Act*; although some may receive specific protection described in a management plan developed as a result of Section 65 of *SARA*. Negative environmental effects on these species may result in their becoming threatened or endangered; therefore, potential environmental effects from the Project must be considered.

7.3.2 Boundaries

The temporal boundaries for the environmental assessment of the Terrestrial Environment VEC includes the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The Assessment Area for Wetland and Vegetation and Wildlife, including Species of Conservation Concern, includes the wetland and riparian environments upstream and downstream of Eel River dam that may be affected by removal of the dam, specifically from the dam to the upper end of the impoundment and from the dam to the Eel River bar (*i.e.*, the estuary below the dam).

Species of Conservation Concern includes those listed:

- as "Species of Special Concern" in *SARA* (including within Schedule 1);
- in *SARA* but not in Schedule 1;
- by COSEWIC but not in *SARA* or the New Brunswick *Endangered Species Act*;

- in the NB Department of Natural Resources General Status List that are ranked as At Risk, May be at Risk, Sensitive, and Status Undetermined; and
- by the Atlantic Canada Conservation Data Centre (AC CDC) with ranks of S1, S2, or S3.

7.3.3 Threshold for Determination of Significance

7.3.3.1 Wetland

The construction of the dam in 1963 has resulted in a substantial decrease in wetland area and particularly in the area of the regionally valued salt marsh. Consequently:

A *significant negative residual environmental effect* on Wetland is one that would not result in a net increase of wetland area towards that which existed before the dam was built and a net increase in salt marsh.

7.3.3.2 Vegetation

A *significant negative residual environmental effect* on Vegetation in wetland and riparian areas is one that:

- causes a decline in common and secure populations in the region of indicator/representative species over one or more generations, and natural population growth may not re-establish the population(s) to original levels; and/or
- causes riparian habitat within the Assessment Area to be altered physically, chemically, or biologically, in such a way as to substantially reduce the likelihood of the long-term survival of Species of Conservation Concern population(s) within the regional population; and/or
- causes direct mortality of many individuals or communities substantially reducing the likelihood of the long-term survival of Species of Conservation Concern population(s) within the regional population; and/or
- in the case of “Species of Special Concern” listed in Schedule 1 of *SARA*, includes Project activities that are not in compliance with the objectives of management plans (developed as a result of Section 65 of *SARA*) that are currently in place.

7.3.3.3 Wildlife

A *significant negative residual environmental effect* on Wildlife would be one that:

- causes a decline in common and secure populations in the region of indicator/representative species over one or more generations, and natural population growth may not re-establish the population(s) to original levels; and/or

- causes wildlife habitat within the Assessment Area to be altered physically, chemically, or biologically, in such a way as to substantially reduce the likelihood of the long-term survival of Species of Conservation Concern population(s) within the regional population; and/or
- causes direct mortality of many individuals or communities substantially reducing the likelihood of the long-term survival of Species of Conservation Concern population(s) within the regional population; and/or
- in the case of "Species of Special Concern" listed in Schedule 1 of *SARA*, includes Project activities that are not in compliance with the objectives of management plans (developed as a result of Section 65 of *SARA*) that are currently in place.

7.3.4 Evaluation of Potential Environmental Effects

7.3.4.1 Status Quo

7.3.4.1.1 Wetland and Vegetation

Wetland

Wetland habitat in the impoundment reflects the relatively constant water level and, while mainly freshwater, is slightly influenced near the dam by the saltwater spray generated by high winds from the ocean, and the occasional saltwater intrusion over the dam during storm surges. The water quality in the impoundment has shown signs of general improvement, due probably to upgrades in sewage treatment facilities upstream along Eel River. There are no other major influences on wetland habitat in the impoundment; therefore, under the Status Quo wetland habitat in the impoundment may be expected to be stable in the current condition for the foreseeable future.

There is a small amount of salt marsh (1.0 ha) in the estuary below the dam. It has been suggested that this has formed since the creation of the impoundment (Hood and Associates, 2000) and that the cause is the accumulation of sediment in the southwest corner of the estuary below the dam. It is possible that under the Status Quo, this salt marsh area might increase slightly in size over time (if it is accepted that the dam construction was the cause of wetland formation). That increase would be nominal in size. This area of salt marsh is subject to constant disturbance from the directly adjacent highway (Route 134) and frequent visitation by campers from the adjacent Blue Heron Campground and local residents. Therefore, in combination with only the possibility of an increase in its very small size, the habitat value is extremely limited.

Importantly, the construction of the dam resulted in a substantial loss of wetland and salt marsh area. This loss will continue under the Status Quo and will not result in a net increase in wetland area towards that which existed before the dam was constructed. Therefore, the environmental effects on wetlands under the Status Quo are rated significant.

Vegetation

Common vegetation in the impoundment is restricted to the wetland and shoreline riparian habitats. Under the Status Quo, it is expected that current regional population levels of common native vegetation will remain stable for the foreseeable future. There are two alien invasive plant species Purple Loosestrife (*Lythrum salicaria*) and Flowering Rush (*Butomus umbellatus*) that have invaded wetland and shoreline habitats in the Assessment Area. Under the Status Quo, these populations will continue to spread and eventually dominate the wetland and shoreline habitats in the impoundment. There are efforts to develop biological control methods being undertaken by federal and provincial organizations but effective control measures will likely not be available for many years.

Six plant Species of Conservation Concern were identified in the Assessment Area:

- Salt marsh Sedge (*Carex recta*; S2);
- Cursed Crowfoot (*Ranunculus sceleratus*; S1);
- Lesser Panicled Sedge (*Carex diandra*; S3);
- Marsh Horsetail (*Equisetum palustre*; S3);
- Water-flaxseed (*Spirodela polyrrhiza*; S2); and
- Tufted Loosestrife (*Lysematchia thrysifolia*; S3S4).

Water-flaxseed, Lesser Panicled Sedge, Marsh Horsetail and Tufted Loosestrife are adapted to freshwater habitats and it is likely that they occur in freshwater habitats upstream along Eel River and in the surrounding region. Salt marsh Sedge and Cursed Crowfoot are adapted to coastal habitats and occur in the lower impoundment where saltwater influence is greatest. Water levels are generally stable and water quality has improved over the past few decades, therefore, no substantive change in these plant populations is expected under the Status Quo for the foreseeable future.

The presence of plant Species of Special Conservation Concern will not be greatly affected, if at all, under the Status Quo. Therefore, the environmental effects of the Status Quo on plant Species of Conservation Concern are rated not significant.

7.3.4.1.2 Wildlife

Wildlife habitat in the Assessment Area reflects the lake-like water level characteristic of the impoundment. While there is a slight influence near the dam by the saltwater spray generated by high winds from the ocean, and the occasional saltwater intrusion over the dam during storm surges, wetland and shoreline habitat is mainly freshwater. No common or uncommon wildlife species that occur are indicator species for coastal habitat. Wildlife species known to occur in the watershed include red fox (*Vulpes vulpes*), coyote (*Canis latrans*), mink (*Mustela vison*), muskrat, raccoon (*Procyon lotor*), beaver (*Castor canadensis*), otter (*Lontra canadensis*), fisher (*Martes pennanti*), ermine (weasel) (*Mustela erminea*), White-tailed Deer (*Odocoileus virginianus*) and red squirrel (*Tamiasciurus hudsonicus*). Most of these species are likely to use the habitat in the Assessment Area. Dense populations of muskrat are reported in the impoundment, where essentially stable water levels and cattails provide suitable habitat. The water quality in the impoundment has shown signs of general improvement, due probably to upgrades in sewage treatment facilities upstream along Eel River. There are no other major influences on wildlife habitat in the impoundment; therefore, under the Status Quo, wildlife habitat upstream of the dam may be expected to be stable in the current condition for the foreseeable future.

The small amount of salt marsh (1.0 ha) in the estuary below the dam is subject to constant disturbance from the directly adjacent highway (Route 134) and frequent visitation by campers from the adjacent Blue Heron Campground and local residents. As such, the wildlife habitat value there is extremely limited. No wildlife species were observed in this habitat during field surveys.

Common wildlife habitat that may be affected by Project activities is restricted to the wetland and shoreline riparian habitats. Under the Status Quo, it is expected that current regional population levels of common native wildlife will remain stable for the foreseeable future. The environmental effects of the Status Quo on wildlife are rated not significant.

No wildlife Species of Conservation Concern are known to occur in the Assessment Area. Therefore, the environmental effects of the Status Quo on wildlife Species of Special Conservation Concern are rated not significant.

7.3.4.2 The Project

7.3.4.2.1 Wetland and Vegetation

Wetland

Decommissioning will result in restoration of unrestricted tidal flow to the entire Eel River estuary. This will cause a permanent change in wetland vegetation within the impoundment area by reducing the amount of freshwater marsh to small fringe locations in the estuary similar to that which existed prior to the construction of the dam. Salt marsh habitat will re-establish in a large portion of the estuary towards levels that will be close to or the same as that which existed prior to construction of the dam.

As mentioned above, there is a small amount of salt marsh in the estuary below the dam, which may have developed recently due to sediment accumulation caused by dam construction. It is possible that Decommissioning will cause some change in the size of this salt marsh by changing sediment transport dynamics in the estuary below the dam. The salt marsh may be reduced in area or removed entirely by tidal scouring. It is also possible that the area of this salt marsh will not change in size, since it is located in a protected part of the estuary below the dam.

The Project will result in a net increase in wetland and salt marsh areas that will be at or close to that which existed prior to the construction of the dam. Therefore, the environmental effects of the Project on wetlands are rated positive.

Vegetation

It is expected that common vegetation in the wetland and around the shores of the impoundment will undergo great change in response to restored tidal flow as the habitat is transformed from a freshwater water habitat to an estuary. However, no common vegetation species will suffer a decline that could measurably alter the regional population levels, with the possible exception of two alien invasive plant species Purple Loosestrife (*Lythrum salicaria*) and Flowering Rush (*Butomus umbellatus*). Following dam removal, it is likely that current population's of Purple Loosestrife and Flowering Rush will be severely reduced or eliminated from the lower impoundment area. Since these are alien invasive species that are associated with negative affects on native vegetation, this is considered to be a benefit of the Project.

Tufted Loosestrife, Water-flaxseed and Marsh Horsetail are adapted to freshwater habitats. These species will not tolerate tidal conditions in the lower estuary; therefore, they will probably be reduced or eliminated from the impoundment area following dam removal. Tufted Loosestrife, Water-flaxseed and Marsh Horsetail are relatively uncommon but are considered "Secure" in New Brunswick by NBDNR. Also, it is likely that they occur in freshwater habitats upstream along Eel River and in the surrounding region.

Lesser Panicled Sedge is found primarily in bog and fen lowlands and is also known to occur in New Brunswick along northern and eastern coastlines. It is relatively uncommon but considered "Secure" in New Brunswick by NBDNR. Collections continue to be made throughout the Province suggesting this species is more common than currently documented. Given its ability to exist along coastlines, this species may tolerate the tidal conditions in the lower estuary. It is possible however, for these populations to change location within the estuary or to increase or decrease in area following dam removal.

Estuary Sedge and Cursed Crowfoot are both adapted to coastal habitats and are capable of tolerating tidal conditions in the estuary, however, it is possible for these populations to change location within the estuary or to increase or decrease in area following dam removal. The status of these species is considered by NBDNR to be "Sensitive", and "May Be At Risk", respectively.

Overall, it is not expected that the Project will result in direct mortality of individuals or communities of Species of Special Conservation Concern to such an extent that such communities would reduce the likelihood of the long-term survival of regional populations. Moreover, the creation of locally uncommon salt marsh will improve opportunities to establish communities of Species of Special Conservation Concern and improve local and regional biodiversity. Therefore, the environmental effects of the Project on Species of Special Conservation Concern are rated not significant, and may be positive.

7.3.4.2.2 Wildlife

The Project will result in restoration of unrestricted tidal flow to the entire Eel River estuary. This will cause a major permanent change in wetland vegetation within the area of the impoundment by greatly reducing the amount of freshwater marsh to small fringe locations in the estuary and causing the production of salt marsh habitat in a large portion of the estuary. This will cause wildlife species dependant on freshwater habitat to move out of the area of the impoundment, while species dependant on saltwater habitat may move in. In particular, the population of muskrat will be eliminated in the area of the impoundment. Freshwater habitat will continue to be available upstream along the Eel River and elsewhere in the surrounding region for any wildlife species, including muskrat, displaced by the change in habitat type.

It is possible that Decommissioning will cause the salt marsh to be reduced in area or removed entirely by tidal scouring. A reduction in the size of this wetland is not expected to cause any substantive environmental effects on the regional population levels of common native wildlife.

Common wildlife habitat that may be affected by Project activities is restricted to the wetland and shoreline habitats. It is expected that current regional population levels of common native wildlife will remain stable for the foreseeable future, under the Project.

No wildlife Species of Conservation Concern are known to occur in the Assessment Area, therefore, no environmental effects from the Project are expected.

Overall, the environmental effects of the Project on wildlife are rated not significant.

7.3.5 Accidents, Malfunctions and Unplanned Events

7.3.5.1 Wetland and Vegetation

There is a possibility that hazardous materials used during Decommissioning could be accidentally spilled and introduced into Eel River. These materials could temporarily degrade water quality and wetland habitat, thus resulting in displaced habitat, reduction in wetland functional values, and direct mortality of Species of Conservation Concern. However, mitigation measures as outlined in the EMP (Section 5.4) will reduce the likelihood of occurrence and potential volumes of such spills (probably less than 200 litres) and provide for their safe and effective clean-up, should they occur. Therefore, environmental effects of a spill would be of limited magnitude and very short duration.

Based on consideration of the potential environmental effects, the proposed mitigation, and the residual environmental effects significance rating criteria, potential environmental effects from accidents, malfunctions and unplanned events on wetland and vegetation in the Assessment Area are not likely, and should they occur, are predicted to be not significant.

7.3.5.2 Wildlife

There is a possibility that hazardous materials used during Decommissioning could be accidentally spilled and introduced into Eel River. These materials could temporarily degrade water quality and wetland habitat, thus resulting in the ingestion/uptake of contaminants by wildlife. However, mitigation measures as outlined in the EMP (Section 5.4) will reduce the likelihood of occurrence and potential volumes of such spills (probably less than 200 litres) and provide for their safe and effective clean-up, should they occur. Therefore, the environmental effects of accidents, malfunctions and unplanned events will be of limited magnitude and very short duration.

Based on consideration of the potential environmental effects, the proposed mitigation and the residual environmental effects significance rating criteria, potential accidents, malfunctions and unplanned events on wildlife in the Assessment Area are not likely, and should they occur, are predicted to be not significant.

7.4 Migratory Birds

7.4.1 Rationale for Selection of VEC

Migratory birds have been selected as a VEC because they are known to be in the area during certain periods of the year and could be affected by the Status Quo and Project. As well, migratory birds are protected under the *Migratory Bird Convention Act*.

Migratory Birds may be subject to changes in habitat type, quantity and/or quality, both upstream and downstream of the dam. Upstream of the dam, the Project will change the freshwater environment to an estuarine environment and may alter wetland and shoreline habitat quality and quantity for Migratory Birds. Downstream of the dam, Migratory Bird habitat may be altered or changed in quality (*e.g.*, due to changes in channel width, depth, hydrodynamics and sediment transport).

During Decommissioning, there is potential for disturbance of migratory birds due to noise and human presence.

7.4.2 Boundaries

The temporal boundaries for the environmental assessment of the Migratory Bird VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The Assessment Area for Migratory Birds will encompass the environment upstream and downstream of Eel River dam. This area may be affected by removal of the dam, specifically from the dam to the upper end of the impoundment and from the dam to the Eel River estuary and the adjacent marine zone bounded by Eel Bay. The Migratory Birds VEC will include waterfowl, shorebirds and other avifauna that use the Assessment Area. Bird Species at Risk are addressed in Sections 3.7 and 7.5.

7.4.3 Threshold for Determination of Significance

A *significant negative residual environmental effect* on Migratory Birds would be one that:

- causes a decline in common and secure populations in the region of indicator/representative species over one or more generations, and natural population growth may not re-establish the population(s) to original levels; and/or
- causes migratory bird habitat within the Assessment Area to be altered physically, chemically, or biologically, in such a way as to substantially reduce the likelihood of the long-term survival of Species of Conservation Concern population(s) within the regional population; and/or
- causes direct mortality of many individuals or communities substantially reducing the likelihood of the long-term survival of Species of Conservation Concern population(s) within the regional population; and/or
- in the case of "Species of Special Concern" listed in Schedule 1 of *SARA*, includes Project activities that are not in compliance with the objectives of management plans (developed as a result of Section 65 of *SARA*) that are currently in place.

7.4.4 Evaluation of Potential Environmental Effects

The Migratory Birds that are known to use the Assessment Area are listed in Tables 3.6.1, 3.6.2 and 3.6.3.

7.4.4.1 Status Quo

Under Status Quo conditions, the impoundment reflects the relatively constant water level and, while mainly freshwater, is slightly influenced near the dam by the saltwater spray generated by high winds from the ocean, and the occasional saltwater intrusion over the dam during storm surges. The birds that currently frequent the impoundment are species adapted to freshwater and related wetlands and riparian habitat. These freshwater species will continue unchanged to use the impoundment under the Status Quo. Therefore, the environmental effects of the Status Quo on Migratory Birds are rated not significant.

No Species of Conservation Concern in the Assessment Area are known to rely on the impoundment area for critical habitat. Therefore, the environmental effects of the Status Quo on Migratory Bird Species of Conservation Concern are rated not significant.

7.4.4.2 The Project

Removal of the dam will result in restoration of unrestricted tidal flow into the Eel River estuary. Below the dam there is currently saltwater habitat that is used by several bird species, including wading birds and ducks. This habitat will remain saltwater. As such, it is not anticipated that any substantial change to habitat will occur.

As a result of tidal flow restoration, the current freshwater impoundment will be converted to a saltwater environment similar to pre-dam conditions. The conversion of freshwater wetland to saltwater wetland in the impoundment will have environmental effects on Migratory Birds in the Assessment Area, as species composition will more closely resemble that of pre-dam conditions and that which currently exists downstream of the dam. Many of the birds present in the impoundment area have the ability to exist in saltwater environments as well including American Bittern, Pied-billed Grebe, Double-crested Cormorant and the Mallard, to name a few. The change in habitat will afford the opportunity of use to species that rely upon tidal estuarine habitat (*e.g.*, shorebirds). Saltwater estuary and saltwater wetland environments are limited in the Eel River region, which makes them more valuable than the more common freshwater habitats, and can be considered positively from a regional biodiversity perspective. Overall, the loss of freshwater habitat upstream of the dam and conversion to a more valued salt marsh habitat is not expected to have a negative environmental effect on Migratory Birds or Migratory Bird Species of Conservation Concern.

Although no Species of Conservation Concern are known to currently rely on the Assessment Area for critical habitat, the potential exists that the Project will provide such habitat. Piping Plover, identified At Risk by the Government of New Brunswick through the New Brunswick *Endangered Species Act* and Endangered under the *Species at Risk Act* (*SARA*), were observed in the sandy portion of the estuary below the dam and on the seaside of the Eel River bar. Semipalmated plover, which have sililar habitat preferences as that of Piping Plover but are not listed as endangered, were observed on the exposed bottom of the impoundment during a period of low water in August 2005 caused by leaky stop logs. This scenario of exposed bottom is consistent with that which will occur once the tidal conditions resume under the Project. Therefore, the environmental effects of the Project on this listed species are rated significant and positive.

Barrow's Goldeneye, a Species of Special Concern under *SARA*, winters in open bays and estuaries along the coast in the Maritime Provinces. This species has been observed on the East Side of Eel River bar. The Project will expand the estuary and provide conditions that may draw Barrow's Goldeneye into the estuary.

The Great Blue Heron, an important tourist feature for the Eel River area, inhabits marshes, both saltwater and freshwater. It is expected that the return to a saltwater marsh will not alter the presence of the Great Blue Heron in the Assessment Area and therefore, the Project is not anticipated to result in significant negative environmental effects.

Overall, it is not expected that the Project will result in direct mortality of individuals or communities of Migratory Birds to such an extent that such communities would reduce the likelihood of the long-term survival of regional populations. Moreover the creation of locally uncommon salt marsh will improve opportunities to establish communities of Migratory Birds and improve local and regional biodiversity. Therefore, the environmental effects on the Project on Migratory Birds are rated not significant and may be positive.

7.4.5 Accidents, Malfunctions and Unplanned Events

There is a possibility that hazardous materials used during Decommissioning could be accidentally spilled and introduced into Eel River. These materials could temporarily degrade water quality and wetland habitat, thus resulting in the ingestion/uptake of contaminants by wildlife, including migratory birds. However, mitigation measures as outlined in the EMP (Section 5.4) will reduce the likelihood of and protect against such spills and provide for their safe and effective clean up, should they occur.

Based on consideration of the potential environmental effects, the proposed mitigation and the residual environmental effects significance rating criteria, potential accidents, malfunctions and unplanned events on Migratory Birds in the Assessment Area are not likely and rated not significant.

7.5 Species at Risk

Species at Risk (extirpated, endangered or threatened) are considered to be all species listed as such under Schedule 1 of the Canadian *Species at Risk Act* (*SARA*) and/or species listed under the New Brunswick *Endangered Species Act*.

Species at Risk that occur in the Maritimes region often represent the northern or southern limit of their natural range and are more common in other regions. Some are restricted to habitat types that are generally uncommon in the landscape, such as coastal wetlands, while some species are scattered and uncommon throughout their range. These species are generally uncommon in occurrence within the region and/or sensitive to human disturbance. Therefore, where such species occur within or near the Project site boundaries there is a potential that the Project may result in significant environmental effects on Species at Risk. Environmental effects may be direct (*i.e.*, affecting individuals) or indirect (*i.e.*, affecting habitat). Species at Risk are frequently dependant on critical habitat necessary for part or all of their life cycle; therefore, environmental effects on vegetation may also have a direct or indirect environmental effect on Species at Risk.

7.5.1 Rationale for Selection of VEC

The federal *Species at Risk Act* (*SARA*) came fully into force in June 2004, as part of a three part national strategy for the protection of wildlife Species at Risk. It includes commitments under the Accord for the Protection of Species at Risk and activities under the Habitat Stewardship Program for Species at Risk. It applies to all federal lands in Canada; all wildlife species listed as being at risk; and their critical habitat. It is intended to complement existing laws and agreements to provide for the legal protection of wildlife species and conservation of biological diversity. The existence of *SARA* is a result of the implementation of the Canadian Biodiversity Strategy, which is in response to the United Nations Convention on Biological Diversity. *SARA* provides federal legislation to prevent wildlife species from becoming extinct and to provide for their recovery. Under *SARA*, an ongoing process of monitoring, assessment, response, recovery, and evaluation will be undertaken to improve the species status and ecosystem.

The Province of New Brunswick provides species protection through its *Endangered Species Act*. Under the *Endangered Species Act*, an endangered species (or sub-species) is any indigenous species of fauna or flora threatened with imminent extinction or imminent extirpation throughout all, or a significant portion of, its range and designated by regulation as endangered. The *Endangered Species Act* prohibits the killing of or interference with any member of an endangered species or the habitat of an endangered or regionally endangered species.

7.5.2 Boundaries

The temporal boundaries for the environmental assessment of the Species at Risk VEC includes the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The spatial boundaries for the environmental assessment of Species at Risk (the "Assessment Area") includes the aquatic, wetland and riparian environments upstream and downstream of Eel River dam that may be affected by removal of the dam, specifically from the dam to the upper end of the impoundment and from the dam to the Eel River bar (*i.e.*, the estuary below the dam).

7.5.3 Threshold for Determination of Significance

A significant negative residual environmental effect on Species at Risk would be one that affects species listed in Schedule 1 of *SARA* as "Extirpated", "Endangered" or "Threatened". It would result in a non-permitted violation of any of the prohibitions stated in Sections 32-36 of *SARA*; or in a non-permitted violation of any of the prohibitions stated in Section 3 of the New Brunswick *Endangered Species Act* (NB *ESA*).

7.5.4 Evaluation of Potential Environmental Effects

7.5.4.1 Status Quo

The Provincial Department of Natural Resources (NBDNR) has declared four bird Species at Risk: Bald Eagle, Peregrine Falcon, Harlequin Duck and Piping Plover. The impoundment has habitat suitable for foraging for the first three.

Eagles have been sighted mainly near the Dalhousie Thermal Plant and Bon Ami Rocks, chiefly in the fall and winter. The most probable reasons for eagles (usually one or two) to concentrate at the Plant and Bon Ami Rocks include the following: ducks are more concentrated at the thermal plant and the Rocks than at the impoundment and the eagles scavenge fish discarded on the ice at the former sites by fishers (Letourneau, pers. comm.). Bald Eagles may occasionally visit the Assessment Area but it is not considered critical habitat for them.

Peregrine Falcon concentrate in the same area as the eagles, especially in fall, presumably because of the concentration of ducks, a favored prey. The chance of success in capturing prey for both or these raptors is enhanced at the Town of Dalhousie Thermal Plant and Bon Ami Rocks as opposed to the impoundment, due to the much greater availability or high perches on the cliffs and rocks at the former sites. Peregrine Falcon have not been seen in the impoundment or estuary and there is no reasonable pathway between the Project and Peregrine Falcon (Bell, pers. comm.). While Peregrine Falcon may occasionally visit the Assessment Area, it is not considered critical habitat for them.

Harlequin ducks may occasionally visit the impoundment, however, they are generally rare throughout the Province except in the western sector of the Bay of Fundy. They have been viewed with offspring annually in the Charlo River estuary for a decade. Paired adults were seen at least once in the Charlo estuary (Hodgson, pers. comm.) and once on the South Charlo River (Ross, pers.comm.), their probable nesting ground. Harlequin Duck nest adjacent to river rapids. Harlequins also nest on nearby Benjamin River, and a brood of young hatchlings was first reported in its estuary in 2000 (Lushington, pers.comm.). Harlequin Duck prefer fast flowing rivers and the marine habitat as opposed to the freshwater habitat found in the Eel River impoundment.

The habitat at the impoundment is not conducive to Piping Plovers, which select open sand beaches on which to nest and forage. The impoundment, therefore, does not appear to be critical to any of the four bird species declared at risk in the Province.

In addition, no other Species at Risk (wildlife, fish, and vegetation) have been identified in the impoundment area and therefore no direct environmental effect is expected. However, it is possible that some Species at Risk could, in the future, use habitat available in the impoundment, under the Status Quo.

Nutrient and other minor contaminant inputs have contributed historically to a reduction in water quality in the impoundment compared to the pre-dam conditions, particularly in the form of algal growth due to eutrophication. There is no evidence that these conditions have caused any environmental effects on potential habitat for Species at Risk in the impoundment. In a general sense it is desirable to reduce contamination in order to improve habitat quality. The sources of contaminant input (sewage effluent) have been incrementally removed and controlled over time. It is expected that changes in water quality in the impoundment will continue to diminish below acceptable or even measurable concentrations and therefore is of little concern for Species at Risk in the Assessment Area.

Currently the shoreline habitat around the impoundment support growing populations of two invasive plant species (Purple Loosestrife and Flowering Rush). It is expected that these species will continue to spread and eventually dominate the vegetative communities of the lower impoundment. These species are considered to displace potential habitat for all native freshwater species including any Species at Risk that could inhabit the impoundment.

The Status Quo will not change habitat characteristics for Species at Risk and therefore the environmental effects on Species at Risk are rated not significant.

7.5.4.2 The Project

Due to the fact that the impoundment has not been identified to be critical habitat for Species at Risk in the Assessment Area, potential environmental effects of its removal are anticipated to be nominal. It is possible that some Species at Risk, including those that currently use the habitat occasionally, could in the future, use habitat available in the restored estuary. There will be a substantial change in vegetation in the wetland and along the shore of the existing impoundment caused by the restoration of tidal flow and estuarine conditions.

Currently the impoundment area contains freshwater marsh and aquatic habitat, which is not uncommon in the region. There are several environmental effects including slightly reduced water quality and the presence of invasive species that could dominate and displace potential habitat for Species at Risk in the impoundment. Removal of the dam will cause restoration of full tidal flow to the estuary, which will restore the impoundment into a saltwater estuary and saltwater wetland. Since estuary and saltwater wetlands are limited in the region they are considered more valuable for Species at Risk than freshwater habitats which are far more common. It is also likely that the area of wetland will increase, which will further enhance the potential for Species at Risk to use the area.

Other potential benefits to Species at Risk will arise from restoration of tidal flow including improved water quality due to tidal flushing in the estuary, and reduced (or eliminated) populations of invasive plant species which threaten to dominate shoreline vegetation within the existing impoundment.

The Project will not result in negative environmental effects on Species at Risk and is therefore rated not significant. The Project may be positive due to the creation of saltwater wetlands and estuarine conditions that are limited in the region.

7.5.5 Accidents, Malfunctions and Unplanned Events

Although undesirable for any environmental component, accidents, malfunctions and unplanned events do not pose a potential environmental effect on Species at Risk due to their absence or limited presence in the Assessment Area. Based on consideration of the potential environmental effects, the proposed mitigation and the residual environmental effects significance rating criteria, potential accidents, malfunctions and unplanned events on habitat for Species at Risk in the Assessment Area are not likely, and should they occur, are predicted to be not significant.

7.6 Water Resources

The Water Resources VEC is comprised of two components: Surface Water and Water Resources Infrastructure. Groundwater was originally considered as a component of the Water Resources VEC to meet the requirements of the EIA Guidelines and because of the potential for the Project to result in changes to groundwater quantity and quality within the Eel River watershed. However, currently there are no groundwater users within the potential zone of influence of the Status Quo or Project, and no environmental effects to groundwater resources are anticipated as a result of the Project. Therefore, the potential environmental effects of the Project on Groundwater will not be considered further in this portion of the assessment due to the lack of a Project-VEC interaction.

7.6.1 Rationale for Selection of VEC

7.6.1.1 Surface Water

Surface Water was selected as a component of the Water Resources VEC because of the potential for interactions between Project activities and bodies of water currently providing or having the potential to provide a freshwater supply to users in the Dalhousie area. In the context of this VEC, Surface Water includes flowing or standing water in lakes, impoundments, ponds, rivers, streams, estuaries, and bays. A key issue is the potential environmental effects of the Project on current users of water from the impoundment, particularly NB Power, and the potential for replacement of this surface water supply with another source.

Efforts to find a replacement water supply for fire protection for the Dalhousie Community Health Centre (CHC) are progressing rapidly. It appears that converting an old coal bunker into a water impoundment for fire protection is a strong possibility (Section 3.8.2.2.2). As such, the potential environmental effects of the Project on the Dalhousie CHC will not be considered further in this portion of the assessment.

7.6.1.2 Water Resources Infrastructure

Water Resources Infrastructure was selected as a component of the Water Resources VEC because of the potential for interactions between Project activities and infrastructure related to water resources in the area. A portion of the 14 km long Charlo River water supply watermain is buried beneath the Eel River, crossing below (east of) the Highway 11 bridge and attaining the North side of the Eel River at the site of the current pumping station. The Project is expected to result in the restoration of the free-flow of tidal waters in the current Eel River impoundment area, and the potential exists for this flow of water to affect the Charlo River water supply watermain buried beneath the Eel River.

7.6.2 Boundaries

The temporal boundaries for the environmental assessment of both of the components of the Water Resources VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

Surface Water

The spatial boundaries (*i.e.*, Assessment Area) for the Surface Water component of the Water Resources VEC include the Eel River and all bodies of water in the vicinity of the Project that have the potential to adequately meet the water supply needs of the current users of the DIWS, including the Charlo River, Eel Bay, Black Brook, Lake Juniper, and wellfields near the Charlo Airport and the community of Mountain Brook.

Water Resources Infrastructure

The spatial boundaries (*i.e.*, Assessment Area) for the Water Resources Infrastructure component of the Water Resources VEC include the Eel River estuary from the Village of Eel River Crossing to the mouth of Eel Bay.

7.6.3 Threshold for Determination of Significance

Surface Water

A *significant negative residual environmental effect* on the Surface Water component of the Water Resources VEC is considered to be one that results in a loss of adequate freshwater supply to current users of the DIWS as a result of the Status Quo or Project.

Water Resources Infrastructure

A *significant negative residual environmental effect* on the Water Resources Infrastructure component of the Water Resources VEC is considered to be one that results in damage to existing water resources infrastructure and subsequently interruption of service to current users.

7.6.4 Evaluation of Potential Environmental Effects

7.6.4.1 Status Quo

7.6.4.1.1 Surface Water

Currently, the DIWS does not provide an adequate water supply for industrial or municipal use. As discussed in Section 3.8.2.1.2, the quality of water in the Eel River impoundment is declining and has proven to be unreliable for both former and current users of the DIWS, including the Bowater paper mill and NB Power generating station in Dalhousie. Bowater attempted to address the problem of high Total Suspended Sediments in the Eel River impoundment water by installing screen filters for its paper mill, but sludge remained and plugged the filters. Once the Charlo River dam water system was upgraded and able to meet the needs of all of the paper mill's operations, Bowater ceased to use the DIWS altogether, specifically because of the poor quality of the Eel River impoundment water.

NB Power has also experienced increasing problems with the water quality in the Eel River impoundment, and has been evaluating alternate water supply sources for some time now. The high conductivity levels in the impoundment water make it unsuitable for use in the boilers of the generating station. High conductivity levels are the result of high chloride concentrations in the water. Since chlorides are a component of saltwater, the high conductivity levels are likely the result of increasing saltwater intrusion into the impoundment due to the failing infrastructure of the DIWS (*e.g.*, leaky stop logs in the dam resulting in the low water level event in July and August 2005). Increased incidents of higher than normal tides and storm surges appear to be a contributing factor as well. NB Power purchased an RO unit to address the problem of high conductivity levels, however, the problem may become aggravated and further issues can be expected to arise with respect to the quality of the water in the Eel River impoundment without the much needed upgrades to the DIWS.

As per the contract with NBENV, and since NB Power is the only remaining user of the DIWS, NB Power would be solely responsible for financing the necessary upgrades to the DIWS, in addition to the regular cost of operating and maintaining the DIWS that it currently sustains. Included in the cost of operating and maintaining the DIWS is the financial compensation for the loss of water resources to the ERBFN in the amount of $204,000 annually, as per their agreement with NBENV. As part of the most recent financial compensation agreement between NBENV and the ERBFN in 2001, NBENV committed to removing the Eel River dam. This contract expires in the summer of 2006, following which the ERBFN is expecting the dam to be removed. In the event that the dam is not removed, the financial compensation can only be expected to increase in amount, and legal action may even be pursued by the ERBFN regarding the loss of resources that are protected under the *Constitution Act* and the *Fisheries Act*.

Under the Status Quo, the DIWS will continue to be an inadequate water supply for NB Power. This is a result of the declining water quality in the Eel River impoundment and subsequent costs of treating the water to make it suitable for use in the generating station; the high costs associated with operating and maintaining the DIWS, namely the required upgrades to the system and the financial compensation to the ERBFN; and the contractual agreement between NBENV and the ERBFN for the removal of the dam. Given that the DIWS is already, and will continue to be, an inadequate freshwater supply for industrial or municipal use, the potential environmental effects of the Status Quo on the Surface Water component of the Water Resources VEC are rated not significant.

7.6.4.1.2 Water Resources Infrastructure

Currently, it appears that the Charlo River water supply watermain that is buried beneath the Eel River is not affected by the existing conditions in the current impoundment area. Therefore, the Status Quo is not expected to result in environmental effects on the Water Resources Infrastructure component of the Water Resources VEC.

7.6.4.2 The Project

7.6.4.2.1 Surface Water

The Project has the potential to result in a negative environmental effect on the Surface Water component of the Water Resources VEC with respect to the loss of immediate freshwater supply for the NB Power generating station, the only remaining user of the DIWS. Stage 2 and Stage 3 of the Project will result in the restoration of the free-flow of tidal waters and subsequently saltwater conditions (or a mix of saltwater and freshwater) in the current Eel River impoundment area. As such, the water level and type of water (saltwater) will not be sufficient for use as a freshwater supply, nor will the necessary infrastructure (*e.g.*, dam, pumping station) be in place and/or operational for providing this service. However, the DIWS is currently an inadequate water supply for the NB Power generating station (as well as former users and any potential future users). As discussed in Section 3.4.1, the water quality in the Eel River impoundment is declining, high costs are associated with operating and maintaining the DIWS (which would be borne solely by NB Power), and a contractual agreement exists between NBENV and the ERBFN for the removal of the dam. The inadequacy of the DIWS is further evidenced by the fact that NB Power is and has been evaluating alternate water supply sources for some time.

Potential alternate water supply sources exist for the NB Power generating station, as discussed in Section 3.8.2.2.2. In particular, the use of Bowater wastewater effluent, the use of sewage effluent from the wastewater treatment facility in Dalhousie, the desalination of seawater from Eel Bay, and the development of a wellfield near the Charlo Airport may warrant further consideration, among others. While replacing the water supply for the generating station with any of these alternatives would require additional expenditure, NB Power already bears considerable future liabilities and costs associated with the DIWS, and these costs would only be expected to increase with the continued use of the DIWS, as discussed above. Further, continued use of the DIWS would infringe upon Aboriginal rights, entitlements and interests that are protected under the *Constitution Act*, and may not comply with the requirements of the *Fisheries Act*.

In summary, the DIWS is already an inadequate freshwater supply for industrial or municipal use, continued use may infringe upon Aboriginal interests, potential alternate water supply sources are available to NB Power, and future liabilities and costs for the provision of a water supply already rest with NB Power. Therefore, the potential negative environmental effects of the Project on the Surface Water component of the Water Resources VEC are rated not significant because the water supply is effectively already lost to NB Power.

7.6.4.2.2 Water Resources Infrastructure

The Project has the potential to cause damage to the portion of the Charlo River water supply watermain that is buried beneath the current Eel River impoundment area, should the watermain be unable to withstand the restored flow of tidal waters over the ground surface. However, it is highly unlikely that this would be the case since the watermain has been in place since the construction of the Charlo River dam in 1929, long before the construction of the Eel River dam in 1963. Between 1929 and 1963, therefore, the watermain was subject to pre-dam conditions involving the twice daily tidal flushing of the current Eel River impoundment area, and was capable of withstanding this flow of water. Bowater Maritimes Inc., current owner of the Charlo River dam, recently installed a new high density PVC watermain inside the existing cast iron pipe that was buried in the Eel River impoundment in 1929.

The Charlo River water supply watermain was capable of withstanding the flow of tidal water in the Eel River prior to the construction of the Eel River dam, and the Project is expected to restore the flow of water in the Eel River to pre-dam conditions. During construction, the proposed rock infill dam will protect against excessive erosion to ensure that scour does not affect the buried watermain. Therefore, the Project is not expected to result in environmental effects on the Water Resources Infrastructure component of the Water Resources VEC.

7.6.5 Accidents, Malfunctions and Unplanned Events

In the Jacques Whitford Study Team's professional judgment, there are no foreseeable features of the Status Quo or Project that would result in accidents, malfunctions or unplanned events that would lead to a significant negative environmental effect to Water Resources, other than unplanned erosion of the Charlo River water supply watermain. Such an event could result in a significant negative environmental effect as it would interrupt the supply to water users. The likelihood of such an unplanned event is very low and any damage could be repaired in a matter of days (at least with temporary repairs). Any other accidents, malfunctions or unplanned events that may occur as a result of the Status Quo or Project would likely be corrected by initiating immediate actions, or implementing mitigation, to cease, control, or prevent a reoccurrence of these events (*e.g.*, hazardous materials spill due to equipment fuelling or faulty vehicle components). These actions and mitigation measures would likely consist of conventional techniques to prevent or remediate the potential environmental effect.

Therefore, the potential environmental effects of the Status Quo on Accidents, Malfunctions and Unplanned Events with respect to Water Resources are rated not significant. Due to an unplanned event that could result in damage to the Charlo River water supply watermain, the potential negative environmental effects of the Project are rated significant, but very unlikely. Otherwise, the potential environmental effects of the Project on Accidents, Malfunctions and Unplanned Events with respect to Water Resources are rated not significant.

7.7 Vessel Navigation

7.7.1 Rationale for Selection of VEC

Vessel Navigation was selected as a VEC to address regulatory issues regarding potential changes in navigational opportunities and vessel traffic on Eel River and Eel Bay, upstream and downstream of the current dam, as a result of the Project.

7.7.2 Boundaries

The temporal boundaries for the environmental assessment of the Vessel Navigation VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The Assessment Area includes the waters upstream and downstream of Eel River dam that may be affected by the Project, from the dam to the upper end of the impoundment and from the dam to the marine environment proximal to the tidal inlet in Eel Bay.

7.7.3 Threshold for Determination of Significance

A *significant negative residual environmental effect* is one where the Project restricts or degrades the existing opportunity for Vessel Navigation in the Assessment Area such that there is a non-compensated net loss of the opportunity for Vessel Navigation in the Assessment Area.

7.7.4 Evaluation of Potential Environmental Effects

7.7.4.1 Status Quo

7.7.4.1.1 Vessel Navigation Above the Dam

The Status Quo will have no substantive environmental effects on Vessel Navigation on the impoundment. However, continued obstruction to the natural flow of the river could promote further proliferation of aquatic vegetation and further hinder navigation of recreational watercrafts, particularly those that are motorized. The continuing deterioration of the control structure could cause negative environmental effects on navigation as occurred in the summer of 2005 when leaking stop logs lead to poor navigation conditions (shallow water, exposed mudflats) in the impoundment.

7.7.4.1.2 Vessel Navigation at the Dam

The dam will continue to be an obstruction to continuous navigation for all vessels.

7.7.4.1.3 Vessel Navigation Below the Dam

The dam has already had a significant negative environmental effect on navigation between Eel Bay and the estuary. The lack of natural tidal action between the Eel River and Eel Bay will continue the process of sediment accumulation in the Eel River estuary and may further reduce the width of the inlet over time. Navigation of recreational boats from Eel Bay into and within the estuary area will remain difficult and the Status Quo has the potential to further negatively affect the opportunity for Vessel Navigation in the future.

7.7.4.1.4 Vessel Navigation Overall

The Status Quo is expected to maintain the present limited opportunities for Vessel Navigation above the dam. The significant negative environmental effects that have resulted from the dam will continue under the Status Quo and may get worse with time. Therefore, the environmental effects of the Status Quo are anticipated to be neutral to negative, but not significant.

7.7.4.2 The Project

7.7.4.2.1 Vessel Navigation Above the Dam

The Project will result in the restoration of the pre-dam tidal exchange and channel dimensions, including the pre-dam width of the inlet of 100 m. During Decommissioning, there may be temporary restrictions placed on operating vessels near the dam excavation site for safety reasons.

The Project will restore the pre-dam estuary conditions above the dam. In the impoundment area, the location and depth of the pre-dam thalweg has not changed substantively since 1963, and as seen in the aerial photographs taken during the summer of 2005, it would appear that the channel geometry remains much as it was pre-dam. Therefore, it is anticipated that pre-dam navigation conditions will be restored quickly upon removal of the dam.

The Project will result in the loss of some navigation opportunity above the dam as portions of the estuary will be high and dry during low tide that would have been consistently under water in the impoundment. However, navigation conditions in the impoundment have deteriorated in recent years, largely due to eutrophic conditions causing excessive aquatic vegetation that fouled propellers. The restoration of the natural estuary will benefit those users that want to canoe or kayak in a natural environment for viewing birds and wildlife, and for the experience in general. Motorized vessels will have complete access to the former area of the impoundment at high tide.

The Project will result in the loss of the unofficial boat access near the existing control structure. However, boat access will remain in the Village of Eel River Crossing.

7.7.4.2.2 Vessel Navigation At the Dam

The removal of the dam will remove the obstruction to navigation at this location. Canoes, kayaks and small vessels will have the potential to navigate from the Village of Eel River Crossing to Eel Bay within obstruction.

7.7.4.2.3 Vessel Navigation Below the Dam

The channel width and depth under the Route 134 bridge and in the estuary below the dam will be returned to its pre-dam dimensions within 10 years of removal of the dam. There may be temporary deposits of eroded material from the estuary or the tidal inlet into the Eel Bay side of the inlet. However, over time storm events and littoral drift will move this material northward along the coast.

There will also be erosion of the bottom of the tidal inlet to an elevation similar to pre-dam conditions, lower than the existing elevation. This will provide the opportunity for recreational powerboat access to the estuary from Eel Bay, and will allow small powerboats to navigate through this area into the portion of the estuary above the dam.

7.7.4.2.4 Vessel Navigation Overall

Vessel traffic may be temporarily restricted near the dam during Decommissioning. In the long term, however, after removal of the dam, access to the estuary from Eel Bay will be greatly improved and navigation opportunity within the estuary will be well suited for those that want to enjoy navigating small craft in a natural setting to view wildlife or to enjoy the restored tidal and river currents. Therefore the environmental effects of the Project on Vessel Navigation are considered to be negative, but not significant, during Decommissioning, and positive after Decommissioning.

7.7.5 Accidents, Malfunctions and Unplanned Events

Accidents, Malfunctions and Unplanned Events are not anticipated to affect Vessel Navigation.

7.8 Transportation Network

7.8.1 Rationale for Selection of VEC

The Transportation Network VEC has been selected to assess the potential environmental effects of the Project on the LOS within the transportation network and on transportation infrastructure.

7.8.2 Boundaries

The temporal boundaries for the environmental assessment of the Transportation Network VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The spatial boundaries of the Transportation Network VEC (*i.e.*, the "Assessment Area") include the four provincial highways in the vicinity of the Eel River dam. These include: Highway 11 (from Route 275 to Route 230); Route 134 (from Dalhousie to Charlo); Route 275 (from Highway 11 to Route 280); and Route 280 (from Route 275 to Route 134), and the CN Rail line.

7.8.3 Threshold for Determination of Significance

A *significant negative residual environmental effect* is one that results in a substantial reduction in the LOS, continuous or semi-continuous obstruction of traffic flow, or the permanent physical loss of any portion of the road infrastructure as a result of the Status Quo or Project.

7.8.4 Evaluation of Potential Environmental Effects

7.8.4.1 Status Quo

The Status Quo is not anticipated to negatively affect the LOS of the road network or the road infrastructure within the Assessment Area during normal operating conditions. In the event that major work is required to repair or replace the existing control structure then some construction related traffic would result. However, this would be short in duration and low in magnitude. The Status Quo will not affect the operation or infrastructure of the CN Rail line. Therefore, the Status Quo is not anticipated to result in significant environmental effects on the Transportation Network VEC.

7.8.4.2 The Project

The increase in traffic activity associated with the Decommissioning period of the Project has the potential to decrease the LOS and highway safety on the transportation network within the Assessment Area, thus there is a potential for the Project to have a negative environmental effect on the Transportation Network. As stated in Section 3.13.1.2, both Highway 11 and Route 134 presently operate at LOS B whose conditions, as defined by the Transportation Research Board, USDOT, Highway Capacity Manual, 2000, for rural highways involve good and stable flow operating conditions. The Project will result in increased construction related traffic during Decommissioning. Although some of this traffic will be workers going to and from the work site, the majority of the traffic will be trucks hauling the removed dam material from its present location to a yet to be selected disposal / reuse site. Although an ultimate disposal site has not been selected, for the purpose of this EIA it is reasonably assumed that the gravel hauling trucks will take the shortest route that permits heavy trucks between the Project site and Highway 11. Once on Highway 11, the trucks are considered to be effectively out of the Assessment Area. The likely trucking route during Stage 2 and Stage 3 will be from the south end of the dam to Route 280 south to Highway 11 interchange with one grade crossing at the CN Rail line.

The total estimated number of 8 m^3 dump trucks required during Stage 2 is 1,775. Given that truck travel is in both directions, the total number of times that trucks will travel over a given section of road during Stage 2 is 3,550. The excavation and hauling portion of Stage 2 will take approximately 8 weeks, for an average of approximately 90 truck passes per day over a given section of the ERBFN hauling route. Stage 3 will require 3,000 of these truckloads, giving a total number of times that trucks will pass over a given section of road during Stage 3 of 6,000. The excavation and hauling portion of Stage 3 will take approximately 10 weeks, for an average of 120 truck passes per day over a given section of the Route 134 hauling route. The small incremental amount of daily traffic on the Transportation Network during Stage 2 and Stage 3 will not result in a decrease of the LOS value. Therefore, although the Decommissioning period of the Project will result in negative environmental effects on the Transportation Network traffic levels that are measurable, these environmental effects are considered as not significant.

The Project may indirectly result in increased traffic during the summer months if the restoration of the natural estuary leads to increased tourism in the Assessment Area. It is not anticipated that tourism-related traffic increases would be of sufficient magnitude or duration to result in a significant environmental effect on the Transportation Network.

The Project will result in the restoration of pre-dam tide conditions. These tides will be higher in energy and larger in extent than those that occur with the dam in place. The Route 134 bridge and the CN Rail bridge were both built prior to 1963, in consideration of the higher tidal energy, and both maintain good structural integrity. The Highway 11 bridge was built after 1963, but to a design standard that is used for bridges where moving water and tides are present. The Highway 11 bridge has not shown substantial damage from water to date. Therefore, the Project is not expected to result in significant negative environmental effects from increased tidal energy acting on Transportation Network infrastructure.

Currently, during the winter months, the impoundment freezes over and there is no horizontal and little lateral movement of ice along the piers of the Highway 11 bridge and the CN Rail bridge. The water in the Eel River estuary below the dam also freezes by early January, effectively keeping the tide from entering the estuary during the winter months. Once the dam is removed, it is anticipated that a similar process will occur, and the tide will not enter the estuary to result in an erosive ice regime from horizontal movement of ice. There will be some lateral movement of ice from the fluctuating input of water from the Eel River, but this will be similar to the movement currently experienced with the dam in place. Although the Project will increase tidal energy back to pre-dam conditions, this will not result in increased erosive forces of ice acting on the transportation infrastructure during the winter months. Therefore, the Project is not expected to result in incremental negative environmental effects from ice acting on Transportation Network infrastructure.

The Project will not result in environmental effects on the volume or flow of traffic on the CN Rail line.

7.8.5 Accidents, Malfunctions and Unplanned Events

The increased level of traffic during Stage 2 and Stage 3 of the Decommissioning period will result in a very small increase to the potential for vehicular collisions. However, this increase will be very small in magnitude (*i.e.*, a few extra trucks per day) and extent (*i.e.*, limited to the route between the dam and the disposal/reuse site), and temporary (*i.e.*, less than 5 months) and reversible. Currently, the majority of accidents within the Assessment Area, and one of three recorded fatal accidents (Table 3.10.1 in Section 3.10), occur along the Rue Principale section of Route 275 within the Village of Eel River Crossing. The Project is not anticipated to result in increased truck traffic in the Village of Eel River Crossing because it is on the other side of Highway 11, the likely destination for the gravel hauling trucks. The total number of accidents (14) along the Route 134 is very low and the addition of a few trucks per day is not expected to increase the likelihood of an accident. Based on consideration of the potential environmental effects, and the residual environmental effects significance rating criteria, and the likelihood of these accidents occurring, the environmental effects of these accidents occurring on the Transportation Network in the Assessment Area are predicted to be not significant. There are no other accidents, malfunctions or unplanned events associated with the Project that are anticipated to occur that would affect the Transportation Network within the Assessment Area.

7.9 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

7.9.1 Rationale for Selection of VEC

Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons was selected as a VEC because of the potential for interactions between the Status Quo and the Project, and the current use of land and resources by the Aboriginal Community. For this VEC, Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons is defined as the use of lands and waterways, and resources within those lands and waterways, that are within the zone of influence of Eel River bar or on adjacent lands where those uses and resources are potentially affected by the Status Quo and/or the Project. This "use" refers to contemporary activities such as hunting, fishing and gathering activities for subsistence purposes as well as the use of lands and resources for social and ceremonial activities.

7.9.2 Boundaries

The temporal boundaries for the environmental assessment of the Use of Land and Resources for Traditional Purposes by Aboriginal Persons VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The spatial boundary for Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons (*i.e.*, the "Assessment Area") is focused on the Eel River watershed with focus on both the watercourse itself and also the adjacent shorelines.

7.9.3 Threshold for Determination of Significance

A *significant negative residual environmental effect* is one where the Project or Status Quo would result in an unmitigated long-term negative change in the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons.

7.9.4 Evaluation of Potential Environmental Effects

7.9.4.1 Status Quo

According to the sources available within the ERBFN, the construction of the dam resulted in the decline of availability of the resources that were used for traditional purposes by Aboriginal Persons. These include gathering of various plant species along the Eel River shorelines, hunting, fishing in what is now the Eel River impoundment area, and the cessation of swimming and boating activities in the vicinity of the dam. In addition, some sections of the 100 hectares of reservation land that was owned by ERBFN at the time of the dam's construction were permanently flooded, reducing the ability of the First Nation members to use the resources in those locations. The continued presence of the dam would perpetuate this problem.

It is believed that the Status Quo may continue to negatively affect the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons in the foreseeable future, as has been experienced since the construction of the dam. It is predicted that maintaining the Status Quo will not reverse the absence or diminished presence of various plant and animal species that were traditionally gathered and fished. This would include the reduction in the quantity of available sweetgrass and blueberry plants growing near the impoundment. Another resource that has reportedly been largely eliminated is the availability of easily accessible and uncontaminated clam beds. The continuation of the Status Quo is unlikely to improve this situation. Fish stocks have also declined in the area of the dam, and therefore fishing of species such as salmon and eels by the Eel River Bar First Nation has reportedly ceased completely. Recreational activities such as boating and swimming in the area on either side of the dam have reportedly declined due to heavy sedimentation and lack of access. The amount of available land for resource use along the shoreline has been reduced due to permanent flooding of the lower shoreline areas of the impoundment. It is unlikely that these activities will resume if the Status Quo is maintained.

The creation of the impoundment has contributed to the development of thriving ecosystems that include substantial populations of beaver and muskrats. However, the majority of the trapping that is done within this area is conducted by non-First Nations individuals and groups, due to the decreasing economic return for pelts. Therefore, although the amount of trapping conducted by the ERBFN members has decreased, this has not been as a result of the dam, and the continued presence or removal of the dam is not anticipated to affect trapping by ERBFN members.

It is not known if the ERBFN current economic development initiatives, such as the Aboriginal Heritage Gardens (AHG), will be negatively affected by the continuation of the Status Quo. It is likely, however, that other future related tourism initiatives that may be planned by ERBFN (such as boating or fishing excursions associated with the AHG, or with their ecotourism program on Heron Island), may be less viable or less profitable if the Status Quo is maintained.

Overall, due to the continued loss of aquatic resources and plant harvesting areas, the potential negative environmental effects of the Status Quo on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons, in consideration of the residual environmental effects significance rating criteria, are predicted to be significant.

7.9.4.2 The Project

It is anticipated that removal of the dam will provide an opportunity for the reversal of the majority of the negative trends that have taken place since the construction of the dam, regarding available resources that were used in traditional ways by the ERBFN members. As discussed in Section 7.2.4.2.3, fish passage will be restored including the opportunity for fish stocks to return, water quality issues in the impoundment will be improved (Sections 7.2.4.2.1 and 7.13.3.2.2), and the heavy siltation of some areas of the impoundment may be reversed (Chapter 6 and Appendix B), improving the quality of the clam habitat (Section 7.13.3.2.3). Due to the anticipated decrease in water levels in the area of the impoundment once the dam is removed, there will be a restoration of floodplain areas, and therefore there may be a corresponding increase in the presence of plants that are gathered for traditional purposes, such as blueberries and sweetgrass. The loss of muskrat populations in the impoundment is negative, but is greatly offset by other positive environmental effects. The increase in traditional plant and animal resources will only serve to reinforce the ecotourism potential of this area, which will be supported and promoted by the adjacent AHG and other ERBFN ecotourism initiatives. In this way, the removal of the dam may promote both economic and cultural growth opportunities for ERBFN. In addition, the use of the areas near the dam for boating and swimming could potentially be restored.

The potential environmental effects of the Project, in consideration of the residual environmental effects significance rating criteria, are predicted to be positive due to their restorative nature with respect to the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons.

7.9.5 Accidents, Malfunctions and Unplanned Events

Hazardous material spills, although they have serious environmental consequences, tend to only affect a local area and tend not to have long lasting effects if properly cleaned up. Therefore although the potential exists for a hazardous material spill to temporarily impact Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons, with proper mitigation long lasting effects are not anticipated.

Based on consideration of the potential environmental effects and the residual environmental effects significance rating criteria, and the environmental effects of Accidents, Malfunctions and Unplanned Events, the effects of the Project on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons in the Assessment Area are anticipated to be positive.

7.10 Tourism and Recreation

7.10.1 Rationale for Selection of VEC

For the EIA, Tourism is defined as an economic subsector of the commercial retail sector of the Eel River system. As such, Tourism is an economic generator and is identified as commercial activity realized by the attraction of consumers originating from elsewhere (*i.e.*, visitors) to the tourism area. The Tourism attraction is identified as the natural, artificial or cultural attributes and supporting infrastructure (*e.g.*, accommodations, restaurants, and cultural/heritage facilities) that appeals to and serves tourists.

For the purpose of this EIA, Recreation is defined as any physical activity and supporting infrastructure located on or adjacent to the Eel River system (Eel River, impoundment, estuary and Eel Bay), that are reliant on the river and its conditions for the enjoyment of those activities. These activities include hiking, hunting/trapping, bird watching, swimming, boating, canoeing, kayaking, recreational fishing and bird watching and any supporting infrastructure such as riverside trails and boat facilities.

Tourism and Recreation has been selected as a VEC to address concerns regarding potential changes to existing recreational activities and facilities, and local tourism, on Eel River and Eel Bay as a result of the potential interactions between the Status Quo and the Project and the Eel River system.

7.10.2 Boundaries

The temporal boundaries for the environmental assessment of the Tourism and Recreation VEC includes the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The Tourism and Recreation Assessment Area is within Restigouche County and includes the Villages of Charlo, Eel River Crossing, Balmoral and the ERBFN, as well as portions of the parishes (Local Service District) of Balmoral and Dalhousie. The boundaries of these municipalities are shown in Figure 3.13.1. The Assessment Area is located at the northwestern end of the Acadian Coastal Drive and at the northeastern end of the Appalachian Range Route tourism regions of New Brunswick.

7.10.3 Threshold for Determination of Significance

A *significant negative residual environmental effect* on Tourism and Recreation is one that results in net long-term losses in tourism or recreational opportunity, compared to conditions observed in 2004 and 2005, that cannot be compensated.

7.10.4 Evaluation of Potential Environmental Effects

7.10.4.1 Status Quo

The Eel River dam has had a negative environmental effect on traditional recreational fish species in the Assessment Area, such as clams, Atlantic salmon, sea-run brook trout, American eel and rainbow smelt. Fishing for traditional recreational fish species is currently limited to sea-run brook trout in the Eel River estuary downstream of the dam, and rainbow smelt in Eel Bay. Fishing in the impoundment will continue under the Status Quo, but is limited primarily to less desirable fish like yellow perch, although some brook trout are caught in the impoundment when water quality conditions are tolerable (*e.g.*, temperature less than 20 °C). The Status Quo will not provide the opportunity for the restoration of the clam fishery or for fisheries for diadromous fish that require passage at the Eel River dam, such as Atlantic salmon, sea-run brook trout, American eel or rainbow smelt.

The Eel River impoundment does provide some limited recreational opportunity for muskrat and beaver trapping, waterfowl hunting and the watching of birds that prefer the habitat. There is also occasional canoeing and kayaking on the impoundment. These activities will be able to continue under the Status Quo.

The Eel River impoundment does not currently provide any Tourism activities (beyond the aforementioned bird watching), and does not appear to have much Tourism generating potential. This will not be changed under the Status Quo.

The Status Quo will continue to allow pedestrian traffic from the NB Trail system to cross over the Eel River dam to the ERBFN lands. However, as noted in Section 3.12.2.2, this trail is not part of the NB Trail system, and is not owned or maintained by any municipal, private or government authority. Currently the trail has some public safety concerns such as the uncontrolled access to the control structure.

Overall, in consideration of the unchanged opportunity for recreational fishing and impoundment-based activities under the Status Quo, the environmental effects of the Status Quo on Tourism and Recreation will be small to non-existent in magnitude and extent, and are therefore considered to be neutral. However, the Status Quo does not appear to provide opportunity for the improvement or enhancement of Tourism and Recreation activities in the Assessment Area.

7.10.4.2 The Project

The Project will result in the loss of the freshwater impoundment, and the restoration of the full former extent of the Eel River estuary. Tidal and fluvial (river) energy will be restored to pre-dam conditions, and the water level within the estuary will reach an elevation at high tide that is similar to that currently observed in the impoundment. The channel opening under the Route 134 bridge will be widened and deepened towards its shape prior to construction of the dam. The freshwater fish habitat of the impoundment will be replaced with a more natural saltwater marsh habitat. The improved tidal energy will also improve overall water quality and will provide the opportunity for the re-establishment of clam populations and saltwater marsh. These physical changes will have environmental effects on existing Tourism and Recreation activities and opportunity.

The loss of the freshwater impoundment will result in the loss of opportunity for the trapping of muskrat and beaver, waterfowl hunting, and the watching of birds that prefer freshwater habitat. There will also be the loss of opportunity for recreational fishing for freshwater species such as yellow perch. Lower water levels at low tide may restrict the use of canoes and kayaks in some areas upstream of the dam at some times. Recreational trout anglers may no longer be able to fish from the shore in the vicinity of the dam as the river channel returns to its natural location along the north shore. Therefore the Project is anticipated to result in negative environmental effects, but not significant, on trapping and hunting, and negative environmental effects on current fishing activities that will be mitigated by new fishing opportunities as described later in this section. The Project will result in negative environmental effects, but not significant, on the viewing of migratory birds that prefer freshwater habitat, because these species can be commonly seen elsewhere in nearby freshwater habitat such as the Charlo dam impoundment, or Popelogan Lake.

The removal of the dam will result in the direct loss of the pedestrian link between the NB Trail system and the ERBFN lands. However, pedestrians will still be able to connect these two areas by detouring further west and crossing the Eel River on the NB Trail system maintained by the Village of Eel River Crossing, or by walking along the Eel River bar to the east. A replacement trail is not recommended as a result of this EIA because the trail along the dam is not part of an official trail system, and is not owned or operated by any group or government agency, and is not necessary to connect the destinations. Therefore the environmental effects of the Project on trail infrastructure is considered to be neutral.

The restoration of natural estuarine conditions is anticipated to result in improved opportunity for natural based tourism and recreation activities. With the removal of the dam, canoes and kayaks will be able to travel the full length of the estuary, unimpeded, from the Village of Eel River Crossing to Eel Bay. Swimming activities near the Route 134 bridge that were popular in the pre-dam period will be possible again as the channel will be wider and deeper then it is at present. Restoration of pre-dam tidal exchange is also expected to widen the inlet from the current width of 30 m to pre-dam conditions of about 90 m at mid-tide elevation, and the bed of the tidal inlet channel will be lowered by approximately 0.8 m. In present conditions, the water is too shallow in the estuary below the dam and the aquatic vegetation growing in the impoundment above the dam clogs boat motor propellers. Removal of the dam, and the consequential increased depth, will improve navigation opportunity for small recreational vessels, including powerboats. Therefore the Project will result in positive environmental effects on vessel based recreation opportunity.

The removal of the dam will restore unimpeded fish passage for diadromous fish species that use Eel River for life cycle purposes. This will greatly improve opportunity within the Assessment Area for recreational fishing for sea-run brook trout, Atlantic salmon, American eel and rainbow smelt. The Project will also result in the opportunity for the re-establishment of clam populations and this will provide increased opportunity for the harvesting of clams as a recreational activity should DFO remove the closed status of this fishery. Therefore the Project will result in positive environmental effects on recreational fishing opportunity.

The hydrodynamic investigation (Appendix B) did not predict that the Project will lead to erosion affecting the Aboriginal Heritage Gardens and/or Blue Heron Campground, and therefore shoreline protection will not be installed along the southern shore of the estuary prior to the removal of the dam. However, shoreline protection will be implemented as contingency if erosion is observed in these areas after the dam is removed. Therefore, it is not anticipated that the Project will have negative environmental effects on existing Tourism and Recreation infrastructure. The Project will restore the natural estuarine environment of Eel River which is considered desirable by the ERBFN, owners and operators of the Aboriginal Heritage Gardens, for the intended purposes of the Aboriginal Heritage Gardens. Therefore, the Project will have positive environmental effects on the potential for the Aboriginal Heritage Gardens to attract visitors. This may consequently lead to an increased need for accommodations in the Assessment Area and increased business for other Tourism services such as restaurants and gas bars.

The Project will result in improved opportunity to view migratory birds that prefer natural estuarine conditions. During the summer of 2005, when impoundment water levels were exceptionally low due to leaking stop logs, Semipalmated Plovers were observed on the freshly exposed substrate. While the Assessment Area is a very active bird watching location, there are no formal bird lookouts. Therefore, the Project is anticipated to have positive environmental effects on recreational viewing of estuarine migratory birds by locals and tourists.

Overall, although the Project will result in some negative environmental effects on hunting and trapping activities and the viewing of migratory birds that prefer freshwater habitat, the overwhelming majority of the environmental effects of the Project on Tourism and Recreation are anticipated to be positive.

7.10.5 Accidents, Malfunctions or Unplanned Events

There are not expected to be any accidents, malfunctions or unplanned events that would have a significant negative environmental effect on Tourism and Recreation. In the event that erosion (an unplanned event) is observed along the south shore of the estuary, then appropriate shoreline protection will be implemented.

7.11 Labour and Economy

7.11.1 Rationale for Selection of VEC

For the purpose of this EIA, Labour refers to the supply and demand for direct skilled and non-skilled labour requirements, as well as the indirect creation of employment in other economic sectors, that may be affected by the Status Quo or Project. Economy refers to the production base of the Eel River region and provincial industry sectors that may be affected during all phases of the Status Quo and Project.

The key issues relating to Labour and Economy are the potential benefits incurred due to the jobs, materials and services associated with the Project, and the potential effects on other economic sectors that incorporate the impoundment area. Due to the importance of jobs and economic well being to an area characterized by high unemployment rates, Labour and Economy has been selected as a VEC to address the changes in employment and economic activities and opportunity that may result from the Project.

7.11.2 Boundaries

The temporal boundaries for the environmental assessment of the Labour and Economy VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

The Labour and Economy Assessment Area is within Restigouche County and includes the Villages of Charlo, Eel River Crossing, Balmoral and the ERBFN, as well as portions of the parishes (Local Service District) of Balmoral and Dalhousie, including the Town of Dalhousie.

7.11.3 Threshold for Determination of Significance

A *significant negative residual environmental effect* on Labour is one that directly affects the current supply and demand of skilled and unskilled labour, ultimately causing degradation to the production base such that there is an uncompensated net loss of employment opportunity that extends beyond the period of Decommissioning.

A *significant negative residual environmental effect* on the Economy is one that induces negative measurable changes in the regional economy and the ERBFN that extend beyond the period of Decommissioning.

7.11.4 Evaluation of Potential Environmental Effects

7.11.4.1 Status Quo

All current employment opportunities associated with the Eel River impoundment, estuary, and Eel Bay are anticipated to continue to exist, as well as those associated with the maintenance of the dam and control structure infrastructure. Ultimately under the Status Quo, the control structure and DIWS infrastructure will require repair or replacement. This work would likely be required within the next 10 years and would generate some employment opportunity with short-term economic benefits resulting from the use of local goods and services. Overall, the Status Quo would have a positive environmental effect on Labour and Economy during the period that the DIWS and dam control structure were under repair or replacement and a neutral (*i.e.*, no change from the present conditions) environmental effect outside of that period.

7.11.4.2 The Project

The Project will eliminate work associated with the operation, maintenance or repair of the dam control structure and the DIWS. However, due to the infrequent maintenance requirements and limited labour required to operate the DIWS, the Project is not expected to have a significant negative environmental effect on Labour associated with the existing dam and impoundment infrastructure.

During the Decommissioning period, labour demand will be created and materials and services will be required. This will create employment for equipment operators and truck drivers, and will increase business at local gas bars, restaurants and possibly places of accommodations for a period up to 2 years. As such, during Decommissioning there will be a net short-term gain in employment opportunity and an increase in the local economy, contributing to an overall positive environmental effect on Labour and Economy during that period.

After Decommissioning, the Project will result in the opportunity for the restoration of commercial fisheries, including the softshell clam and rainbow smelt. The Project will negatively affect those fish species that benefit or rely to some extent on the presence of the shallow freshwater impoundment, specifically the yellow perch, white sucker, the 4-spine stickleback and various minnow species. Replacing the populations of these "coarse" fish species with restored populations of valued diadromous commercial fish species and clams represents a potential positive environmental effect on Labour and Economy in the Assessment Area as this may lead to increased commercial or Aboriginal fishing opportunity.

The Project is anticipated to increase the potential number of visitors to the Aboriginal Heritage Gardens. This may require the need for more staff at the Aboriginal Gardens, and may also indirectly lead to economic benefits to local businesses that provide goods or services for tourists. Therefore the Project is anticipated to result in long-term positive environmental effects (*i.e.*, increased employment and economic benefits) to businesses, and therefore Labour and Economy, within the Assessment Area.

7.11.5 Accidents, Malfunctions and Unplanned Events

In the unplanned event that the Project resulted in damage to the Bowater water line infrastructure, then there would be significant negative environmental effects on Labour and Economy in the Town of Dalhousie and for the owners and employees of the Bowater paper mill. However, the Project is not anticipated to affect the Bowater water line for the reasons discussed in the Water Resources VEC (Section 7.6), and therefore this unplanned event is considered to be highly unlikely. There are no other accidents, malfunctions or unplanned events associated with the Project that are anticipated to occur that would affect Labour and Economy within the Assessment Area.

7.12 Archaeological and Heritage Resources

7.12.1 Rationale for Selection of VEC

Archaeological and Heritage Resources are defined as any physical remnants found on top of and/or below the surface of the ground that inform us of past human use of and interaction with the physical environment. These resources may be from the earliest prehistoric times of human occupation up to the relatively recent past and may include both built and depositional resources (*i.e.*, trash or lost goods) that are considered important for bettering our understanding of the people and their practices who once inhabited these areas. For this EIA, Archaeological and Heritage Resources will also include historic structures and palaeontological resources (*e.g.*, fossil remains of plants and animals).

Archaeological and Heritage resources are known to exist along the banks of almost every navigable watercourse in New Brunswick, although no comprehensive archaeological survey has ever been conducted along Eel River.

The Status Quo and/or the Project may cause changes to the flow and erosion patterns of Eel River and changes to the water level of the impoundment, which could potentially affect Archaeological and Heritage Resources. Archaeological and Heritage Resources are therefore included as a VEC in recognition of the interest of potentially affected First Nations, the general public, and provincial and federal regulatory agencies assuring the effective management of these resources.

Archaeological and Heritage Resources may be affected by surficial or subsurface Project-related disturbance of the area within which these resources are located. The assessment of the environmental effects of decommissioning on Archaeological and Heritage Resources is focused principally on those Project activities (including related geotechnical investigations) that entail ground disturbance, and that may negatively affect Archaeological and Heritage Resources.

7.12.2 Boundaries

The spatial boundaries for the Archaeological and Heritage Resources VEC (*i.e.*, the "Assessment Area") are the Eel River dam and adjacent shorelines. This inculdes locations where there are likely to be environmental effects to lands that may contain heritage or archaeological resources, such as any ground disturbance or increased erosion of riverbanks in the impoundment area and Eel River estuary downstream, as well as portions of the river that have been flooded as a result of the construction of the dam.

The temporal boundaries for the environmental assessment of the Archaeological and Heritage Resources VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

7.12.3 Threshold for Determination of Significance

In regard to this Project, significant archaeological resources are defined as those sites, such as living areas, that can inform us on the customs and living practices of the Mi'kmaq and early European settlers on and around Eel River. Individual artifacts (described by provincial archaeological regulator, Archaeological Services Unit, as "find spots") are not typically considered "significant" (from a regulatory perspective) as they provide only minimal information on the past.

A *significant negative residual environmental effect* is a Project-related disturbance to, or destruction of, an archaeological or heritage resource (including palaeontological resources) considered by the provincial heritage and archaeological regulators to be of major importance ("significant") due to factors such as rarity, undisturbed condition, spiritual importance, or research importance, that cannot be mitigated.

7.12.4 Evaluation of Potential Environmental Effects

7.12.4.1 Status Quo

The construction of the Eel River dam has caused a minimal amount of erosion of the shoreline in the Eel River estuary on the south shore near and downstream of the current water control structure. This is an area of high archaeological potential, and therefore, it is possible that damage or destruction of archaeological and heritage resources could result from maintaining the Status Quo. Furthermore, the modification in the original location of the main river channel in the impoundment area, from the northern shoreline (around Blueberry Point) to its current location along the southern shoreline, may have negatively affected submerged sites in the impoundment area through erosion. The extent of this environmental effect on the archaeological resources cannot be known.

There is the possibility that some unknown archaeological or heritage resources on or near to the shorelines have been submerged and/or buried by factors such as sea level rise, flooding in the impoundment area due to dam construction, and increased siltation of these areas after the construction of the dam.

The Status Quo can be expected to cause minimal damage or destruction to the historic shorelines (*i.e.*, pre-dam shorelines) of Eel River, through continued erosion along the southern shoreline of the impoundment. The potential negative environmental effects of the Status Quo on Archaeological and Heritage Resources, in consideration of the residual environmental effects significance rating criteria, are likely to be not significant, but may be significant due to a disruption of currently unknown resources.

7.12.4.2 The Project

Modelling indicates that it is likely the removal of the dam will largely restore the tidal flow of Eel River, and will result in the restoration of the original river channel, and the erosion of the siltation in the impoundment that resulted from the presence of the dam (Chapter 6). It is also probable that a number of previously unrecorded and/or unidentified archaeological and heritage resources may exist along the Eel River.

The removal of the dam will take place in three stages, as described in Chapter 5. The initial placement of rip-rap on the shoreline at Blueberry Point (Figure 5.1.1), in Stage 2, should be preceded by an archaeological assessment of the shoreline. If any currently unknown archaeological sites are located along the erosional face of this point, the installation of the rip-rap could negatively affect these sites. It is also likely that a staging area will be created for the second stage of construction, and therefore once the location for this area is confirmed, an archaeological survey and testing of this location will be required.

In Stage 2 of the Decommissioning, the removal of the northern 150 m of the dam is not likely to require any archaeological mitigation. However it is anticipated that this stage of the Project will result in the rapid return of water levels in the impoundment to pre-dam levels. If this does occur, then there is the possibility that sections of newly exposed shoreline, floodplains and islands may be subjected to erosion. Therefore it is recommended that all shoreline areas in the current impoundment and upriver portions that have been flooded as a result of the dam undergo a comprehensive archaeological survey in order to determine the condition of archaeological and heritage resources within the Assessment Area, once water levels in the impoundment area have decreased, and ground conditions allow. If any archaeological sites are encountered during this survey, their condition will need to be evaluated in relation to the threat that may result from erosion and the threat from unauthorized digging and theft of artifacts once exposed.

Stage 3 of the Decommissioning involves the removal of the remaining dam structure, and will not require any immediate archaeological mitigation.

The potential negative environmental effects of the Project on Heritage and Archaeological Resources, in consideration of the residual environmental effects significance rating criteria and the suggested mitigation, are predicted to be not significant.

7.12.5 Accidents, Malfunctions and Unplanned Events

Hazardous material spills, although they can have serious environmental consequences, tend to only affect a local area and tend not to have long lasting effects. However, in the event of a hazardous material spill along a shoreline, contaminated soil will have to be excavated and disposed of in an appropriate manner. In such an event, the provincial regulator may, depending upon the potential of the location, require that a licensed archaeologist be present as the soil is excavated in the event that the contaminated site contains archaeological material. If a hazardous materials spill is located in an area where it may rapidly become a threat to human health or wildlife safety (such as near a watercourse or well field), then concerns for health and safety will pre-empt concerns for any potential archaeological resource, and containment should proceed immediately, regardless of the presence of an archaeologist.

The Project has the potential to result in an accidental disturbance to archaeological resources. Depending on the nature, extent and magnitude of the disturbed resource, the environmental effect could be significant, but this is considered very unlikely to occur, as the Project is not anticipated to result in erosion or scouring of land beyond what existed prior to 1963.

If an unknown archaeological or heritage resource is encountered during construction, then all work should be stopped in the immediate area, and the Archaeological Services Unit should be contact for guidance on the proper mitigation of the resource.

Based on consideration of the potential environmental effects, the proposed mitigation, and the residual environmental effects significance rating criteria, the environmental effects of Accidents, Malfunctions and Unplanned Events on Archaeological and Heritage Resources in the Assessment Area are predicted to be not significant.

7.13 Public Health and Safety

7.13.1 Rationale for Selection of VEC

The Status Quo and Project have the potential to result in environmental effects on Public Health and Safety. These environmental effects may arise primarily from unplanned natural events (storms, extreme high tides) that are made worse by the Project, or through changes in the environment that may have implications for public health and safety (*i.e.*, flooding, water contaminated with coliform bacteria and food resources). Given these issues and concerns, Public Health and Safety has been selected as a VEC and is organized into the following sub-components: Flooding and Flood Risk; Bacteriological Environment; and Food Resource Contamination.

Although traffic accidents from increased trucking activities during Decommissioning would be of concern to Public Health and Safety, this issue is considered in the Transportation Network Section 7.8.

7.13.1.1 Flooding and Flood Risk

Flooding and Flood Risk are issues of concern for Public Health and Safety in the Assessment Area.

7.13.1.2 Bacteriological Environment

The Bacteriological Environment has been selected as a component of this VEC because fecal coliform bacteria are known to occur in the potential zone of influence of the Status Quo and the Project and may be subject to changes in the quantity both upstream and downstream of the dam.

7.13.1.3 Food Resource Contamination

The existing level of contaminants in fish and softshell clams in the Eel River area was raised as an issue for concern in meetings with the Aboriginal Community, stakeholders and the public.

7.13.2 Boundaries

The spatial boundaries for the Public Health and Safety VEC (the"Assessment Area") includes the environments upstream and downstream of Eel River dam that may be affected by removal of the dam, specifically from the dam to the Village of Eel River Crossing and from the dam to the Eel River bar (*i.e.*, the estuary below the dam) and beyond in Eel Bay. The Assessment Area includes all areas of the floodplain and adjacent land areas the have the potential to be flooded during extreme events (*i.e.*, below the dam crest elevation of 3.4 m).

The temporal boundaries for the environmental assessment of the Public Health and Safety VEC include the Decommissioning period out to 10 years after removal of the dam is complete. These temporal boundaries are defined as per the reasons mentioned in Section 2.2.3.

7.13.3 Threshold for Determination of Significance

7.13.3.1 Flooding and Flood Risk

A *significant negative residual environmental effect* on Public Health and Safety from flooding is one that would result in an increase in risk to Public Health and Safety over the existing conditions. Under the Status Quo, the crest elevation of the Eel River dam is at 3.4 m, which is higher than the normal operating water level of 1.98 m. Therefore upstream flooding in excess of elevation 3.4 m is considered an exceedance of existing conditions.

7.13.3.2 Bacteriological Environment

A *significant negative residual environmental effect* on Public Health and Safety from recreational contact of bacteriological contaminated waters would result when the CCME recreational guideline of 200 fecal colifoms (*E. coli*) per 100 mL is exceeded (CCME, 1998).

7.13.3.3 Food Resource Contamination

A *significant negative residual environmental effect* on Public Health and Safety would occur when food resources (*e.g.*, fish and clams) are contaminated beyond the maximum limits established in the *Canadian Food and Drugs Act* (1991).

In regard to direct consumption of clams from shellfish growing areas, a *significant negative residual environmental effect* on Public Health and Safety would also occur when the most probable number (MPN) of fecal coliforms in water exceed a median or geometric mean of 14 per 100mL and 10 percent of the samples exceed 43 fecal coliforms per 100 mL in areas approved for shellfish harvesting. These are Environment Canada's bacteriological standards for the consumption of shellfish in shellfish harvesting waters in Canada (taken from Richard and Godin, 2003).

7.13.4 Evaluation of Potential Environmental Effects

7.13.4.1 Status Quo

7.13.4.1.1 Flooding and Flood Risk

As a consequence of constructing the Eel River dam, the Province of New Brunswick purchased properties adjacent to the impoundment and river in the Village of Eel River Crossing because of anticipated flooding risks for the Status Quo. The basis for the purchase is no longer known but it is assumed that the properties were purchased below the dam crest elevation of 3.4 m. Some homes were relocated further away from the river banks and shoreline at higher elevations, and others were moved elsewhere. Occasionally flooding below 3.4 m results in environmental effects on community infrastructure. For example flooding still occurs in the area of the ballfields in the Village of Eel River Crossing. This is a temporary inconvenience and no property damage occurs. This flooding is likely a result of a backwater effect at the control structure during peak runoff events and may be made worse on occasion by manual operation of the gates (*i.e.*, a failure to respond effectively to hydrological events). Under the Status Quo, these conditions would remain the same.

Currently, the dam limits storm surge and extreme high tide in the estuary from entering the impoundment and contributing to high water levels in the river (except at the fishway and weir). This could be considered a positive environmental effect of the Status Quo as this protection will continue.

Overall, the environmental effect of the Status Quo on the Flooding and Flood Risk component of Public Health and Safety is rated not significant as the dam does result in some flooding upstream, but not to a level that would be different from existing conditions.

7.13.4.1.2 Bacteriological Environment

The bacteriological water quality in the impoundment has shown signs of general improvement in 2005, likely as a result of the Eel River Crossing sewage lagoon and outfall decommissioning (Section 3.15.2.2; Table 3.15.3). However, the outfall from the Balmoral sewage lagoon in the south branch of Eel River, stormwater outfalls and runoff from adjacent villages to the Eel River are potential sources that contribute to existing elevated levels of fecal coliform bacteria observed upstream of the impoundment that exceed CCME guidelines for recreational contact (Section 3.15.2.2). These conditions will persist under the Status Quo.

Fecal coliform concentrations downstream of the dam in the estuary and at the tidal inlet have not decreased as a result of the above noted decommissioned sewage lagoon and lower coliform concentrations measured in the impoundment water in 2005. The persistent and relatively higher levels of coliform bacteria in the estuary below the dam under the Status Quo are being attributed to the waterfowl that frequent the estuary in large numbers during the ice-free period and the reduced flushing of the estuary below the dam. The installation of the dam has resulted in sedimentation below the dam that has narrowed the main channel and reduced channel conveyance and tidal exchange. The bacteriological environment for the Status Quo may be expected to be similar to the current condition for the foreseeable future and are likely an indirect result of the presence of the dam.

The environmental effects are considered to be negative and significant because of the potential for public health and safety issues through recreational contact and exposure to coliform-containing waters in the Eel River adjacent to Dundee (Unincorporated), the Villages of Eel River Crossing and Balmoral and in the estuary below the dam.

7.13.4.1.3 Food Resource Contamination

The food resources in the Assessment Area are not contaminated with bioaccumulating chemicals such as metals, including mercury, and PCBs as defined by the maximum limits for contaminants under the *Canadian Food and Drugs Act* (Section 3.15.3). Resident fish species upstream of the dam, and as measured in yellow perch in 2005, are not contaminated with these chemicals at levels of concern with respect to these limits (Section 3.15.3; Table 3.15.4). Similarly, the clams in the estuary are also not contaminated with these chemical substances at levels of concern with respect to these limits.

The fecal coliform concentrations measured in 2005 by Environment Canada in the estuary and along Eel River bar in the bay are sufficiently high to maintain the ban on harvesting clams in these shellfish areas as per the established bacteriological water standards for shellfish growing areas (Section 3.15.2). Fecal coliform concentrations downstream of the dam in the estuary are attributed to the waterfowl that frequent the estuary in large numbers during the ice-free period and poor flushing attributed to the continued environmental effects of the dam on the hydrodynamics and sediment transport. The construction of the dam has contributed to the infilling of the estuary downstream of the dam with sediment, thereby creating a shallower estuary with a reduced tidal volume and flushing capacity of the estuary compared to pre-dam conditions. This reduction in tidal flushing capacity of the estuary under the Status Quo is likely contributing to the retention of fecal matter produced by waterfowl in the estuary. This is contributing to the public health risk of coliform contaminated food resources, specifically the clams in the estuary and bar that will continue with the Status Quo. Therefore, the environmental effects of the Status Quo are rated negative and significant on Public Health and Safety because of coliform contaminated food resources that are apparently a result of sediment infilling, reduced capacity of the tides to flush the estuary and smaller tidal prism related to the presence of the dam. The bacteriological contamination of this food resource for the Status Quo may be expected to remain in the current condition for the foreseeable future. This would result in a continued ban on the recreational and commercial harvesting of the shellfish fishery in this area by Environment Canada.

7.13.4.2 The Project

7.13.4.2.1 Flooding and Flood Risk

Decommissioning the dam will result in restoration of unrestricted tidal flow to the entire Eel River estuary. It is conceivable that the impoundment area, including the ballfields in the Village of Eel River Crossing, may be subject to additional flooding risk as a result of extreme high tide and potential sea level rise in the distant future. The area of the ballfields were likely flooded under pre-dam conditions. It is not anticipated that the maximum rise in water level will be above the elevation of 3.4 m within the next 10 years nor even by the year 2100, taking into account potential extreme tides and sea level rise due to global warming (combined potential water level elevation of 3.26 m). The potential negative environmental effects of the Project on flooding in consideration of the residual environmental effects significance rating criteria are therefore predicted to be not significant.

7.13.4.2.2 Bacteriological Environment

The Project will result in restoration of unrestricted tidal flow to the entire Eel River estuary, with flushing of the entire estuary twice daily because of the tide and by a substantially higher tidal volume than for the Status Quo. This will have a very positive environmental effect on the concentration of fecal coliforms in the estuary with respect to recreational contact of this water. The hydrodynamic modelling investigation predicts that for full dam removal, the tidal prism moving into and out of the Eel River estuary will increase from the present Status Quo volume of 0.59 million m^3 to 1.9 million m^3 for a mean tide of 1.1 m (geodetic) at high tide. More importantly, full tidal exchange in a more open channel and tidal inlet will result in an effective flushing of the estuary with each tide. This will greatly reduce the build up of fecal coliform bacteria that currently occur in the estuary to levels that are well below the CCME guidelines for recreational contact.

Upstream of the dam, the Project will not dilute the concentration of coliforms to any appreciable level in the vicinity of the Village of Eel River Crossing. It is not anticipated that the intrusion of salt water will reach this point with the tide, even though the water level at this location will fluctuate with the tide cycle. However, restoration of unrestricted tidal flow throughout the length of the estuary will promote the flow of coliform-containing waters out of this area with the outgoing tide, and reducing optimal conditions for coliform survival (*e.g.*, higher flow and less warm temperatures) as compared to the Status Quo. Therefore the Project is expected to result in some positive environmental effect upstream of the impoundment.

Overall, it is concluded that the Project will result in positive environmental effects on the bacteriological environment and Public Health and Safety.

7.13.4.2.3 Food Resource Contamination

The Project over the long term may potentially reduce the level of heavy metals and mercury in food resources found within the area of influence of the tidal prism, and specifically on filter-feeding aquatic animals like mussels and clams. This is a result of the higher tidal volume that may flush potential contaminants out of the estuary and as new populations of clams are established within the estuary. It is expected that the fecal coliform concentrations in the estuary and along Eel River bar in the bay may be reduced below bacteriological water standards of Environment Canada for shellfish growing areas. This may remove the ban on harvesting clams in these shellfish areas for direct consumption (Section 3.1.5.2.2). It is anticipated that the fecal matter produced by waterfowl using the estuary may become diluted and flushed out of the estuary as a result of a deepening estuary, wider tidal inlet and a higher tidal volume and flow associated with the removal of the dam (Section 7.13.3.2.2). Therefore, the environmental effects for the Project are considered to be positive because of the potential reduction in public health risk from coliform bacteria in shellfish growing areas and the possibility of lifting the ban on the recreational and commercial harvesting of shellfish in the Assessment Area and the opportunity for the restoration of these fisheries.

7.13.5 Accidents, Malfunctions and Unplanned Events

7.13.5.1 Flooding and Flood Risk

It is not anticipated that Accidents, Malfunctions and Unplanned Events may contribute to increased flooding risk during Decommissioning, as excavation of the dam will occur during the ice-free period, and the rock wall barrier will control the rate at which water enters the impoundment area.

Based on consideration of the potential environmental effects, the proposed mitigation, and the residual environmental effects significance rating criteria, potential effects on Public Health and Safety from Accidents, Malfunctions and Unplanned Events on flooding and flood risk in the Assessment Area are not likely and are predicted to be not significant.

7.13.5.2 Bacteriological Environment

There is a possibility that sewage wastes from temporary holding facilities or during pumping for transport may be accidentally spilled and introduced into Eel River during Decommissioning. These wastes could temporarily degrade water quality with fecal coliforms, thus resulting in potential for increased contact with contaminated waters and increased risk for public health and safety. However, mitigation measures as outlined in the EMP (Section 5.4) for other waste materials and spills will reduce the potential volume of such spills and provide for their safe and effective clean-up, should they occur. Therefore, environmental effects of potential Accidents, Malfunctions and Unplanned Events from sewage wastes will be of limited magnitude and very short duration.

Based on consideration of the potential environmental effects, the proposed mitigation and the residual environmental effects significance rating criteria, potential Accidents, Malfunctions and Unplanned Events on Public Health and Safety from sewage wastes in the Assessment Area are not likely, and should they occur, are predicted to be not significant.

7.13.5.3 Food Resource Contamination

There is a possibility that hazardous materials used during Decommissioning could be accidentally spilled and introduced into Eel River. These materials could temporarily degrade water quality and contaminate food resources in the water and on dry land if released there, such as ingestion of contaminated blueberries. However, mitigation measures as outlined in the EMP (Section 5.4) will reduce the potential volume of such spills (probably less than 200 litres) and provide for their safe and effective clean-up, should they occur; therefore, environmental effects will be of limited magnitude and very short duration.

Based on consideration of the potential environmental effects, the proposed mitigation, and the residual environmental effects significance rating criteria, potential effects from Accidents, Malfunctions and Unplanned Events on Public Health and Safety from contamination of food resources in the Assessment Area are not likely, and should they occur, are predicted to be not significant.

8.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

8.1 Background

The definition of "environmental effect" under Section 2(1) of *CEAA* includes "any change to the project that may be caused by the environment". The guidance documentation of the Canadian Environmental Assessment Agency does not specifically address how this aspect is to be assessed. Typically, this is accomplished by: identifying and describing the aspects of the environment (*e.g.*, erosion) that could have an effect on the Status Quo or Project; describing the nature of the effects (*e.g.*, accumulation of sediment around the dam); and providing a description of the mitigation (*e.g.*, erosion control measures, such as rip-rap) to minimize the risk from the identified effects of the environment on the Project. The aspects of the environment that may cause a change in the Status Quo or Project are:

- sediment transport process (erosion and deposition);
- tidal prism (energy and extent);
- weather (precipitation, temperature and wind);
- flooding;
- ice;
- climate change (including sea level rise); and
- earthquake activity.

8.2 Threshold for Determination of Significance

A significant negative effect of the environment on the Status Quo or Project would result in:

- damage to Status Quo or Project infrastructure, or loss of schedule, resulting in a long-term interruption in service or repairs that could not be technically or economically implemented; or
- failed mitigation causing environmental damage that could not be technically and economically corrected or compensated in a feasible manner.

8.3 Evaluation of the Potential Effects of the Environment

This section provides the evaluation of how each aspect of the environment affects the Status Quo and Project.

8.3.1 Status Quo

Evaluating the potential effects of the environment on the Status Quo is to evaluate how the environment will affect the dam and control structure.

8.3.1.1 Sediment Transport Process

Sediment transport is determined by forces such as tidal energy and river base flow acting to erode and suspend sediment particles in areas of high energy and deposit sediment particles in areas of low energy. This process is hereafter referred to as the sediment transport process.

In the period since construction of the dam, the sediment transport process has not been in equilibrium as the estuary and impoundment area have experienced some sediment deposition as a result of sediment sources from the watershed and Eel Bay. This trend is expected to continue into the future under the Status Quo. As a result, sediment plugs may accumulate above the dam, and potentially affect the operation of the dam in the future, although significant effects are not anticipated. Currently, erosion is occurring along the banks and in the channel directly downstream of the control structure such that sediment plugs have not been a problem.

8.3.1.2 Tidal Prism

The current tidal prism is not expected to result in a significant environmental effect on the dam or control structure under the Status Quo as the dam is designed to withstand a more substantive tidal prism than exists at baseline conditions. The size of the tidal prism has been decreasing since 1963 as the estuary below the dam and the inlet continue to decrease in channel dimensions.

8.3.1.3 Weather (Precipitation, Temperature and Wind)

The weather is not expected to result in a significant effect on the dam or control structure under the Status Quo within the next 10 years.

8.3.1.4 Flooding

Flooding waters from the spring freshet or extreme precipitation event is not expected to result in a significant effect on the dam or control structure under the Status Quo.

8.3.1.5 Storm Surge

Storm surge has been known to overtop the gates of the control structure in recent years. Although this does have negative environmental effects on the impoundment, this has not resulted in damage to the control structure, therefore storm surge is not likely to result in a significant effect on the dam or control structure under the Status Quo.

8.3.1.6 Waves

The dam and control structure are largely protected by the Eel River bar from the potential effects of waves. Extreme waves, such as large run-up waves or tsunamis, could significantly damage the dam and control structure (particularly the dam), though these events are extremely rare in the region, and are considered unlikely to occur.

8.3.1.7 Ice

During the winter months, ice forms over the impoundment area upstream of the dam. Because the dam, for the most part, prevents tidal salt water from penetrating into the impoundment area, the ice in the impoundment consists of freshwater and forms ice cover earlier and is somewhat thicker than ice formed in a typical tidal estuary in this region of the Province. As a result of the accumulation of ice in the impoundment, ice jams can form at the dam gates, which have the potential to affect the operation of the dam. This is expected to continue into the future under the Status Quo, though the effect is not expected to be significant.

8.3.1.8 Climate Change

In 2001, the Intergovernmental Panel on Climate Change (IPCC) issued the following projections for global climate change over the next 100 years for the Assessment Area (IPCC, 2001):

- an increase in annual mean temperature of 4 to 5 Celsius degrees;
- a slight increase in annual mean precipitation (daily amount on a day when it rains or snows) of 5 mm; and
- an increase in mean sea level of 0.09 to 0.88 m (average predicted value of 0.5 m).

In addition, the global climate modelling work of Meteorological Service of Canada scientists at the Climate Modelling and Analysis Centre in Victoria, British Columbia determined that return periods for significant rainfalls could be reduced by as much as a factor of two. Therefore, heavy rainfall amounts with a return period of 100 years could occur once in 50 years, for example.

Very little information exists with respect to projections for relative sea-level rise as a result of climate change, in combination with other vertical forces, in the Chaleur Bay specifically. As stated in Section 6.1.4, the Intergovernmental Panel on Climate Change (2001) predicts that the global mean sea level could rise 0.09 to 0.88 m by 2100. Unpublished global positioning system (GPS) results from the Geodetic Survey Division of Natural Resources Canada in Ottawa suggest that there may be ground subsidence occurring at nearby Bathurst (Forbes, pers. comm.). Subsidence results in a relative increase in sea level as the ground loses elevation compared to the sea. In contrast, an analysis of vertical motion in the region by Azadeh Koohzare *et al.*, (2005) shows an uplift of 0.5 mm/year at Bathurst (Forbes, pers. comm.). Any vertical motion of the earth's crust, whether slight subsidence or slight uplift, will not likely be great in northern New Brunswick. Therefore, climate change is antifipated to be the dominant cause of sea-level rise in the Assessment Area in the future.

The coastal sensitivity (*i.e.*, the degree to which a coastline may experience physical changes such as flooding, erosion, beach migration, and coastal dune stabilization) to sea-level rise for the Eel River

Assessment Area has been rated as moderate (Shaw *et al.*. 1998, cited in The Atlas of Canada, 2005). A coastal erosion study for the Charlo area was initiated in the summer of 2004 by a student from the Miramichi Community College, and is currently being reviewed by the Geological Surveys Branch of NBDNR (Bérubé, pers. comm.). This study covers the entire shoreline of the Village of Charlo, as well as the sand silt located at the mouth of Eel River. Four sets of air photos were used to conduct the study (1944, 1974, 1997 and 2005). It is anticipated that the results of this study, in the form of coastal erosion maps, will be made public in the near future, at which time further information on erosion sensitivity to climate change in the Assessment Area will be available.

As discussed above, the potential effect of climate change on sea level in the Assessment Area remains unclear and requires further study. Should the sea level in the Assessment Area rise, however, it has the potential to affect the operation of the dam under the Status Quo, especially if it is combined with the predicted increase in precipitation. This could result in the need to raise the height of the dam. The control structure could require replacement if it cannot be retrofitted to withstand increased sea level.

An increase in annual mean temperature of 4 to 5 Celsius degrees is not expected to have a significant effect on the dam or control structure under the Status Quo.

8.3.1.9 Earthquake Activity

The following text is an excerpt from the internet publication "*A Summary of the Historical Earthquake Activity in the Province of New Brunswick*" by Dr. Kenneth B.S. Burke (Burke, 2004).

> *Because of its remoteness, the record of historical seismicity for the Central Highlands region is incomplete. A few earthquakes have been reported in the Bathurst area, with a 4.3 mN earthquake on July 2, 1922 and a 4.5 mN earthquake on September 30th. A 4.6 mN earthquake on January 4, 1930 at Blackville, just southeast of the Central Highlands, was felt throughout most of the Miramichi valley. A 4.7 mN earthquake at Trousers Lake on June 16, 1982 was felt to a distance of 150 km away.*

A seismic disturbance greater than the design base earthquake could result in damage to the dam or control structure. Given that the probability of a seismic disturbance of such magnitude is very low, however, earthquake activity is not expected to result in a significant effect on the dam or control structure under the Status Quo.

8.3.2 The Project

Evaluating the potential effects of the environment on the Project is to evaluate how the environment will affect the Decommissioning effort.

8.3.2.1 Sediment Transport Process

During Stage 2 of the Project (*i.e.*, the removal of approximately 150 m of the northern portion of the dam), the tidal energy and river flow velocities may exceed normal pre-dam conditions as a result of the narrow channel during excavation. This could lead to the scouring of the channel to a depth greater than existed pre-dam. As a result, the rock barrier (as described in Section 5.1.2) will be installed as part of the Project to minimize flow velocities and prevent excessive scour. No significant effects are predicted on the Project from the sediment transport process.

8.3.2.2 Tidal Prism

As a result of the Project, the tidal prism is expected to extend upstream of the dam as far as the original head of tide near the Village of Eel River Crossing. The increased energy and extent of the tidal prism will affect the Project as part of the process described for the sediment transport process in Section 8.3.2.1. No significant effects are predicted on the Project from the tidal prism.

8.3.2.3 Weather (Precipitation, Temperature and Wind)

The primary effect of weather on the Project is the temporary delay of Decommissioning activities during periods of inclement weather. Inclement weather may present a safety hazard for workers, or make it difficult to perform specific Decommissioning activities. The schedule for the Project will be designed in anticipation of weather induced delays, but the Project is not ultimately sensitive to short-term and temporary delays.

8.3.2.4 Flooding

Excessive flood waters could delay the initiation of Stage 2 of Decommissioning as the impoundment should be drawn down prior to breaching the dam. Flooding is not expected to have a significant effect on the Project.

8.3.2.5 Ice

The excavation phase of Decommissioning will occur during the open water season, as such, it is not anticipated that ice will have a significant effect on the Project.

8.3.2.6 Climate Change

Climate change occurs slowly and over long periods of time. Therefore, climate change is not anticipated to result in a significant effect on the Project during the Decommissioning period.

8.3.2.7 Earthquake Activity

A high magnitude earthquake could have a significant effect on Decommissioning, however this is considered extremely improbable.

8.3.3 Comparative Assessment

Engineering planning and design always involves consideration of the effects of the environment on a project, and the planning and engineering design for this Project are no exception. However, the Project is an environmental restoration effort, and does not involve permanent infrastructure. In this regard, the Project is not particularly sensitive to effects from the environment. In contrast, the Status Quo does include the dam and control structure infrastructure, and is sensitive to effects from the environment.

The sediment transport process, tidal prism, flooding and the weather have the potential to affect Stage 2 of the Project. However, the rock wall barrier will minimize and control flow velocities to prevent excessive scour and provide a safe working environment during Decommissioning. All effects of the environment on the Project will be limited to the Decommissioning period and are therefore temporary.

By contrast, the effects of the environment on the Status Quo will likely persist in the form of sediment plugs, ice jams, and potential need for retrofitting as a result of climate change and sea level rise.

9.0 CUMULATIVE ENVIRONMENTAL EFFECTS ANALYSIS

9.1 Methods and Scope

The EIA Guidelines (Appendix A) require that an assessment of cumulative environmental effects must be conducted in consideration of each identified VEC, for both positive and negative cumulative environmental effects. Within these parameters, and as stated in the Terms of Reference, cumulative environmental effects were assessed following the guidance of the Canadian Environmental Assessment Agency (*e.g.*, CEA Agency 1994; 1999) and Operational Policy Statement.

Under *CEAA* 16(1)(a), every screening of a project shall include a consideration of "any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out". As defined in the *Cumulative Effects Assessment Practitioners Guide* (the "Practitioners Guide") (Hegmann *et al.*, 1999), cumulative environmental effects are "*changes to the environment that are caused by an action in combination with other past, present and future human actions"; where actions are defined as "any project or activity of human origin*".

As also stated in the Practitioners Guide, "*Cumulative effects are not necessarily that much different from effects examined in an EIA; in fact, they may be the same*." For this EIA, the above statement is true with few exceptions. These exceptions are further described in Section 9.2 and relate to future actions that will be carried out and that have the potential to have environmental effects that will act in combination with those of the Project. This is consistent with the following excerpt from the Practitioners Guide, "*With the exception of the consideration of future actions, the requirements of cumulative effects assessment are identical to the requirements of a good EIA (the consideration of the effects of other actions is not necessarily new to cumulative environmental effects as the existing environmental setting of a project has typically recognized other actions at least within the EIA's study area).*" In this regard, Table 9.1.1 summarizes what cumulative environmental effects have been considered in the EIA Report prior to this chapter.

Table 9.1.1 Cumulative Environmental Effects Considered In Previous Chapters

Chapter	Description of How Cumulative Environmental Effects Were Considered
Chapter 3 (Description of the Environment)	Provided a summary of the detailed pre-dam (before 1963) and post-dam and existing (1963 – 2005) conditions. For example, Chapter 3 provides trends over the time frame of available information for wetland change using aerial photos and traffic levels using past traffic counts. Chapter 3 also includes a discussion of the contribution of past and present projects to the existing environmental conditions such as the discharge of partially treated sewage from sewage lagoons of communities along the Eel River and the transportation network infrastructure (*e.g.*, Highway 11 bridge).
Chapter 4 (Evaluation of Existing Fish Passage Conditions and Potential Alternatives to the Project for Achieving the Fish Passage Project Objectives)	Expands on the discussion from Chapter 3 for the issue of fish passage. In Chapter 3, the combined environmental effects of past and present actions on the ability of fish to migrate within Eel River for life cycle purposes are provided in detail. A detailed description of the past and present operation of the dam and control structure, including the fishway, on fish passage is provided. Also included in the discussion are other past and present impediments to fish passage such as the reduction of DO levels from the discharge of sewage effluents into the river.

Table 9.1.1 Cumulative Environmental Effects Considered In Previous Chapters

Chapter	Description of How Cumulative Environmental Effects Were Considered
Chapter 5 (Project Description)	Presents a detailed description of the Project. Included in the Project Description is mitigation (*e.g.*, protection of shoreline and the permeable rock barrier) intended to minimize the magnitude and/or likely occurrence of environmental effects, and therefore, to varying degrees, the cumulative environmental effects.
Chapter 6 (Description of the Future Anticipated Changes to the River)	Provides a summary of the results of the modelling investigation which considered the environmental effects of past projects such as the presence of bridge piers and the narrowed Eel River inlet, a result of the historical presence of the Eel River dam.
Chapter 7 (Environmental Effects Analysis)	Presents the environmental effects assessment of the Project for each VEC, in consideration of past and present conditions, reflecting the cumulative environmental effects of past and present actions in combination with the Project.

As presented in Table 9.1.1, the EIA Report has already considered the cumulative environmental effects of the Status Quo and Project acting in combination with other past and present actions. However, there are other cumulative environmental effects of the Status Quo and Project that have not been previously considered. Most notably these include the cumulative environmental effects of the Status Quo and Project with other future actions on socio-economic VECs and on biophysical VECs.

The Guidelines do not provide a specific guidance on the scope of the cumulative environmental effects assessment. Therefore, the scope of the cumulative environmental effects assessment was done following the guidance of the Practitioners Guide (Hegmann *et al.*, 1999). As per the Practitioners Guide, it is important to note that for a project (*i.e.*, the Project or Status Quo) to have the potential to result in a cumulative environmental effect, the project must have a measurable environmental effect.

It is important to note that this Project is an environmental restoration project, and as such, most of the resulting environmental effects of the Project are overwhelmingly positive. In this regard, the decision was made to place more emphasis of the cumulative environmental effects assessment on the negative environmental effects predicted to result from the Project, although positive cumulative environmental effects were considered and are noted where appropriate. The positive and negative cumulative environmental effects of the Status Quo were also assessed for comparative purposes.

The first step of cumulative environmental effects analysis is to quantify if there are environmental effects resulting from the Project or Status Quo. If so, then it must be established if the environmental effects of the Project or Status Quo overlap with those of other past, present, or future actions. Finally, the significance of the cumulative environmental effects that result from the overlap must be determined. In this regard, cumulative environmental effects assessment is an analysis of how the environmental effects of the Project or Status Quo contribute to the cumulative environmental effects of past, present and future actions acting on an environmental component.

The cumulative environmental effects assessment follows these steps:

- **STEP 1** – Describe the environmental effects on each of the VECs of the Status Quo and Project (summarized from Chapter 7);

- **STEP 2** – Describe the potentially measurable environmental effects on each of the VECs of other actions that may interact with the Status Quo and Project;
- **STEP 3** – Identify the potential interactions (cumulative environmental effects) of the Status Quo and Project with the other actions;
- **STEP 4** – Evaluate the significance of the resulting cumulative environmental effects on each of the VECs; and
- **STEP 5** – Recommend mitigation to minimize the identified cumulative environmental effects, if warranted.

Each of the above steps are presented in Section 9.2, 9.3, 9.4 and 9.5, respectively.

9.2 Summary of the Environmental Effects of the Status Quo and the Project

The analysis of the environmental effects of the Status Quo and the Project Options (Step 1) was carried out in Chapter 7 (Environmental Effects Analysis) of this EIA Report and is summarized in Table 9.2.1.

Table 9.2.1 Summary and Comparison of Key Environmental Effects of the Status Quo and Project

VEC	Key Potential Environmental Effects Resulting from the Status Quo		Key Potential Environmental Effects Resulting from the Project	
	Negative	**Positive**	**Negative**	**Positive**
Atmospheric Environment	None predicted.	None predicted.	Emissions and noise generated by earth moving equipment and trucks during Decommissioning (NS).	None predicted.
Fish Habitat and Fish	Will continue to result in significant environmental effects on Fish Habitat by maintaining the obstruction to fish passage, the low quality habitat of the impoundment, and the poor water quality. Will continue to result in significant environmental effects on Fish by preventing the re-establishment of native diadromous fish populations.	None predicted.	Loss of freshwater fish species in area of impoundment (NS).	Fish passage will be restored. Water quality will be improved. Saltwater estuary will be restored.
Terrestrial Environment	Will continue to result in significant environmental effects on wetlands.	Will maintain beaver and muskrat habitat in the impoundment.	Loss of freshwater beaver and muskrat habitat in the area of the impoundment (NS).	Restoration of saltwater marsh vegetation and wildlife.
Migratory Birds	None predicted.	None predicted.	Loss of low quality freshwater habitat (NS).	Net gain of locally uncommon saltwater marsh habitat.
Species at Risk	None predicted.	None predicted.	Loss of low quality freshwater habitat (NS).	None predicted.
Water Resources	None predicted.	None predicted.	None predicted.	None predicted.
Vessel Navigation	Will continue to result in significant negative environmental effects by maintaining the existing navigation obstruction (the dam and control structure), and the poor access to the Eel River estuary from Eel Bay.	None predicted.	Loss of small vessel navigation opportunity in area of impoundment during low tide (NS).	Restored contiguous navigation from Village of Eel River Crossing to Eel River bar. Improved access from Eel Bay to the Eel River estuary. Reduced aquatic vegetation in the former area of the impoundment.
Transportation Network	None predicted.	None predicted.	Increased traffic levels during Decommissioning (NS). Increased tourism-related traffic after Decommissioning (NS).	None predicted.

Table 9.2.1 Summary and Comparison of Key Environmental Effects of the Status Quo and Project

VEC	Key Potential Environmental Effects Resulting from the Status Quo		Key Potential Environmental Effects Resulting from the Project	
	Negative	Positive	Negative	Positive
Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons	Will continue to result in significant negative environmental effects on the opportunity for Aboriginal Persons to engage in the traditional harvesting of fish and plants.	Will maintain the opportunity to trap beaver and muskrat in the impoundment.	Loss of freshwater habitat for muskrat and beaver (NS).	Restoration of traditional fish and clam populations. Restoration of traditional plant communities.
Tourism and Recreation	None predicted.	None predicted.	Loss of the unofficial trail over the Eel River dam (NS).	Increased recreation opportunity. Increased tourism potential.
Labour and Economy	None predicted.	None predicted.	None predicted.	Short-term labour need during Decommissioning. Improved economy and creation of jobs from long term increase in tourism.
Heritage and Archaeological Resources	None predicted.	None predicted.	Accidental disturbance to archaeological resources could be significant, but is considered unlikely.	None predicted.
Public Health and Safety	The significant negative environmental effects on water quality (bacterial) in the upper portion of the impoundment will remain. The softshell clam fishery will remain closed due to potential bacterial contamination.	The dam and control structure will continue to provide limited protection against extreme high tides and storm surge up to an elevation of 3.4 m.	The risk of flooding to land along the former area of the impoundment, below an elevation of 3.4 m, will be increased slightly (NS).	The bacterial levels in the impoundment will be improved to acceptable levels. The softshell clam fishery may be re-opened pending review by Environment Canada.

NS = Not Significant

9.3 The Environmental Effects of Other Actions That May Overlap Those of the Project

This sections describes the potentially measurable environmental effects on each of the VECs of other actions that may interact with the Status Quo and Project (Step 2).

9.3.1 Cumulative Environmental Effects Assessment Boundaries

The temporal boundaries for the consideration of cumulative environmental effects analysis was defined as beginning at the point in time at which background knowledge was sufficient and extending into the reasonably foreseeable future (approximately 5 years) for the selection of other projects that will be carried out.

The spatial boundaries for the consideration of environmental effects (the "Assessment Area") as presented for each VEC in Chapter 7 were defined by the extent of the regional issues associated with each VEC. For example, for the environmental effects analysis of changes to Water Resources, the Assessment Area includes all current and former users of the Eel River impoundment and groundwater (none identified), and the locations of other potential alternate sources of water for these users.

9.3.2 Cumulative Environmental Effects Thresholds for Determination of Significance

The cumulative environmental effects significance criteria are the same as the environmental effects significance criteria presented in Chapter 7 as these were defined by the extent of the regional issues associated with each VEC.

9.3.3 Selection of Projects That Will be Carried Out

The selection of projects that will be carried out was accomplished in consultation with the TRC and in communication with the regional municipalities. These projects were selected based on their proximity to Eel River, the potential for interactions with the environmental effects of the Project, and the likelihood of the project(s) being carried forward (*e.g.*, the project is registered, or is in the EIA process, with the Province under the *EIA Regulation*). Future activities were selected based on public and regulatory consultation, regional issues of concern, and the professional judgment of the Jacques Whitford Study Team.

The projects and activities that will be carried out and the environmental effects of which could potentially act in combination with the environmental effects of the Project are presented and described in Table 9.3.1. Included in the table is a summary of the key potential environmental effects of the projects. It should be understood that the level of information for each project varies as most have not completed the environmental assessment process and do not have well developed project descriptions at this time.

Table 9.3.1 Other Future Projects For Consideration of Cumulative Environmental Effects

Name of Project	Description of Project	Key Potential Environmental Effects of Project
The Aboriginal Heritage Gardens	• Restore natural estuarine conditions in Eel River. • Showcase approximately 270 species of plants that have been traditionally used by the Aboriginal people for medicinal and other purposes. • Located on 110 acres of previously undeveloped lands previously associated with the Chaleur Provincial Parc (now the Blue Heron Campground). • Scheduled to open summer 2006. • Includes approximately 3 km of walking trails. • Includes research facilities.	• Clean-up of the Eel River impoundment and improvement to water quality at the mouth of Eel River. • Improved opportunity for nature based tourism. • Improved opportunity for estuary and beach recreational activities. • Improved opportunity for navigation of small crafts, including kayaking and canoeing.
Restigouche Naturalist Club Waterfowl Habitat Restoration	• Excavation of two 0.25 ha ponds to restore freshwater wetland habitat in Tide Head Marsh.	• Regional addition of fresh water wetland habitat.
Village of Charlo Tourism Development	• Construction of a multipurpose building.	• Improved opportunity for development of tourism.
Village of Balmoral Sewage Aeration System	• Construction of an aerated sewage treatment facility to service the Village of Balmoral	• Reduction to bacteria and nutrients entering Eel River.
Village of Atholville Water Supply Evaluation	• Evaluation of an existing municipal well (Kodiac Lodge well) to see if production can be increased to supplement the water supply for the Village of Atholville.	• Greater extraction of regional groundwater supply.
Commercial Fishing	• Local, regional and global commercial fishing for diadromous fish populations that use Eel River for life cycle purposes.	• Direct mortality of individual fish comprising diadromous fish populations that use Eel River for life cycle purposes.

9.4 Identification of Potential Cumulative Environmental Effects

Step 3 of the cumulative environmental effects assessment is to identify where the environmental effects of the Project and Status identified in Step 1 (Section 9.3.1) overlap in a substantive way with those of the other actions identified in Step 2 (Section 9.3.2). This is done using an interaction matrix, included here as Table 9.4.1. In Table 9.4.1, the key environmental effects of the Project and the Status Quo are compared with the anticipated key environmental effects of the other actions. A "✓" was placed where a likely and substantive interaction could occur within the spatial and temporal boundaries. The evaluation of the identified potential cumulative environmental effects occurs in Section 9.4.

Table 9.4.1 Cumulative Environmental Effects Interaction Matrix

VALUED ENVIRONMENTAL COMPONENTS	ACTIONS					
	Aboriginal Heritage Gardens	Restigouche Naturalist Club Waterfowl Habitat Restoration	Village of Charlo Tourism Development	Village of Balmoral Sewage Aeration System	Village of Atholville Water Supply Evaluation	Commercial Fishing
Atmospheric Environment						
Fish Habitat and Fish	✓			✓		✓
Terrestrial Environment	✓	✓				
Migratory Birds	✓	✓				
Species at Risk	✓					
Water Resources						
Vessel Traffic and Navigation			✓			
Transportation Network	✓		✓			
Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons	✓	✓		✓		✓
Tourism and Recreation	✓		✓			
Labour and Economy	✓		✓			✓
Heritage and Archaeological Resources	✓					
Public Health and Safety				✓		

9.5 Evaluation of Potential Cumulative Environmental Effects

This section (Step 4) is the evaluation of the potentially substantive cumulative environmental effects that were identified in Step 3 (Section 9.4).

9.5.1 Fish Habitat and Fish

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Fish Habitat and Fish:

- Aboriginal Heritage Gardens;
- Village of Balmoral Sewage Aeration System; and
- Commercial Fishing.

9.5.1.1 Status Quo

The Status Quo will continue to result in significant environmental effects on Fish Habitat by maintaining the obstruction to fish passage, the low quality habitat of the impoundment, and the poor water quality of the impoundment. The ERBFN has undertaken some cleanup of contaminated sites within the area of the impoundment that has helped to improve the quality of Fish Habitat in this area. The Village of Balmoral Sewage Aeration System will help to reduce the levels of bacteria and nutrients entering the impoundment. Regardless of the positive environmental effects of these other actions on

Fish Habitat, the environmental effects of the Status Quo are much greater in magnitude and duration and will therefore continue to result in significant negative cumulative environmental effects on Fish Habitat.

The Status Quo will continue to result in significant environmental effects on Fish by preventing the re-establishment of native diadromous fish populations. Commercial fishing in the future will continue to harvest diadromous fish that use Eel River for life cycle purposes. Most notably, the commercial harvesting of Atlantic salmon in international waters results in direct mortality to Atlantic salmon that may spawn in rivers located throughout the North Atlantic, including Eel River. The environmental effects of the Status Quo acting in combination with those of commercial fishing will result in cumulative environmental effects that are greater in magnitude than the Status Quo acting alone. Therefore, the cumulative environmental effects of the Status Quo and other actions on Fish within the Assessment Area are considered as negative and significant.

9.5.1.2 The Project

The Project will result in environmental effects on Fish Habitat that are positive as the poor water quality of the freshwater impoundment will be changed to an estuarine body of water with good water quality. The ERBFN has undertaken some cleanup of contaminated sites within the area of the impoundment that has helped to improve the quality of Fish Habitat in this area. The Village of Balmoral Sewage Aeration System will help to reduce the levels of bacteria and nutrients entering the impoundment. The environmental effects of these other actions, in combination with the already positive environmental effects of the Project, will result in positive cumulative environmental effects on Fish Habitat in the Assessment Area.

The Project will restore the opportunity for diadromous fish to pass unimpeded from the marine environment of Eel Bay to the freshwater environment of Eel River. The Project will also restore the saltwater estuary which is an important transition zone for diadromous fish as they undergo physiological changes that allow them to extract oxygen from either fresh or saltwater. Commercial fishing in the future will continue to harvest diadromous fish that use Eel River for life cycle purposes, particularly Atlantic salmon as discussed above for the Status Quo. Commercial fishing may have environmental effects on some fish species that are greater in magnitude than the positive environmental effects of the Project on those specific species. However, overall, the cumulative environmental effects of the Project acting in combination with commercial fishing is anticipated to be positive for most diadromous fish species that use Eel River for life cycle purposes, and therefore for Fish Habitat and Fish within the Assessment Area.

9.5.2 Terrestrial Environment

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on the Terrestrial Environment:

- Aboriginal Heritage Gardens; and
- Restigouche Naturalist Club Waterfowl Habitat Restoration.

9.5.2.1 Status Quo

The Status Quo will maintain the freshwater impoundment that is used by some freshwater wildlife, particularly muskrat and beaver, and some birds that prefer freshwater habitat. The Waterfowl Habitat Restoration project will add approximately 0.50 ha of freshwater habitat in the region. The Aboriginal Heritage Gardens is located in near proximity to the freshwater impoundment, and the clearing and developing of this land may disturb wildlife associated with the impoundment. However, the combined positive environmental effects of the Status Quo and the Waterfowl Habitat Restoration project on the freshwater wildlife are expected to outweigh the negative environmental effects of the clearing of land for the Aboriginal Heritage Gardens on freshwater wildlife.

However, the Status Quo will continue to result in significant environmental effects on saltwater wetlands and associated wildlife and vegetation by preventing the restoration of the full extent of the Eel River estuary and saltmarsh area to that which existed prior to construction of the dam in 1963. This negative and significant environmental effect on the Terrestrial Environment outweighs the potentially positive cumulative environmental effects contribution from the Status Quo and other actions on the freshwater wildlife described above. Therefore, the overall cumulative environmental effects of the Status Quo and other actions on the Terrestrial Environment is considered to be negative and significant.

9.5.2.2 The Project

The Project will result in the loss of the freshwater habitat provided by the impoundment, and will therefore have some negative, but not significant, environmental effects to freshwater wildlife like beaver and muskrat, and birds that prefer freshwater habitat. The Aboriginal Heritage Gardens is located in near proximity to the freshwater impoundment, and the clearing and developing of this land may disturb wildlife associated with the impoundment. The 0.50 ha of freshwater habitat created by the Waterfowl Habitat Restoration project will help to offset this loss of freshwater habitat in the region and the disturbance to wildlife, however, the overall cumulative environmental effects of the Project and other actions on freshwater habitat are considered to be negative.

The Project will result in the restoration of saltmarsh in the Eel River estuary to levels that approach or equal that which existed prior to 1963 that is considered a very positive environmental effect. This positive environmental effect on the wetland and vegetation component of the Terrestrial Environment outweighs the potentially negative cumulative environmental effects contribution from the Project and other actions on the freshwater wildlife described above. Therefore, the overall cumulative environmental effects of the Project and other actions on the Terrestrial Environment is considered to be positive.

9.5.3 Migratory Birds

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Migratory Birds:

- Aboriginal Heritage Gardens; and
- Restigouche Naturalist Club Waterfowl Habitat Restoration.

9.5.3.1 Status Quo

The cumulative environmental effects of the Status Quo and the Waterfowl Habitat Restoration and the Aboriginal Heritage Gardens on Migratory Birds are the same as those described for the Terrestrial Environment (Section 9.5.1.2.1).

9.5.3.2 The Project

The cumulative environmental effects of the Project and the Waterfowl Habitat Restoration project and the Aboriginal Heritage Gardens on Migratory Birds are the same as those described for the Terrestrial Environment (Section 9.5.1.2.2).

9.5.4 Species at Risk

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Species at Risk:

- Aboriginal Heritage Gardens.

9.5.4.1 Status Quo

The Status Quo will continue to provide freshwater habitat for some Species at Risk such as the osprey and bald eagle. The cumulative environmental effects of the Status Quo and the Aboriginal Heritage Gardens on freshwater habitat, and therefore on these Species at Risk, are the same as those described for the Terrestrial Environment (Section 9.5.1.2.1).

9.5.4.2 The Project

The Project will restore the natural estuary thereby improving conditions for some Species at Risk like the Harlequin Duck. The cumulative environmental effects of the Project and the Waterfowl Habitat Restoration project on the estuary, and therefore Migratory Birds, are the same as those described for the Terrestrial Environment (Section 9.5.1.2.2).

9.5.5 Transportation Network

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Species at Risk:

- Aboriginal Heritage Gardens; and
- Village of Charlo Tourism Development.

9.5.5.1 Status Quo

The Status Quo will not result in environmental effects on the Transportation Network, and therefore there are no cumulative environmental effects associated with the Status Quo.

9.5.5.2 Project

The Project will result in increased traffic levels during Decommissioning. The Aboriginal Heritage Gardens will likely be in operation during the period of Decommissioning and will result in additional traffic levels on the local roads from tourists visiting this attraction. However, the resulting level of traffic from the Project in combination with the Aboriginal Heritage Gardens is not anticipated to result in a reduced LOS on local roads during Decommissioning.

In the long-term, the Project will likely increase tourism-related traffic as more visitors come to experience the nature based recreation provided by the natural estuary. The Aboriginal Heritage Gardens is anticipated to increasingly draw tourists and associated traffic to the Assessment Area over time, with estimates as high as 80,000 visitors. The Village of Charlo Tourism Development may also result in long-term increases to tourism and associated traffic in the Assessment Area that may overlap with that created by the Aboriginal Heritage Gardens and the Project. However, the resulting level of traffic from the Project in combination with the Aboriginal Heritage Gardens and the Village of Charlo Tourism Development is not anticipated to result in a reduced LOS on local roads in the long-term. Therefore, the overall cumulative environmental effects of the Project acting in combination with the other identified actions on traffic levels in the Assessment Area is considered as negative, but not significant for both the period of Decommissioning and over the long-term.

9.5.6 Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons:

- Aboriginal Heritage Gardens;
- Restigouche Naturalist Club Waterfowl Habitat Restoration;

- Village of Balmoral Sewage Aeration System; and
- Commercial Fishing.

9.5.6.1 Status Quo

The Status Quo will continue to result in significant negative environmental effects on the opportunity for Aboriginal Persons to engage in the traditional harvesting of fish, clams and plants in the Assessment Area. As described for Fish Habitat and Fish in Section 9.5.1.1, Commercial Fishing will have significant negative cumulative environmental effects with the Status Quo on Fish. The Village of Balmoral Sewage Aeration System will help to improve water quality in the impoundment, but this will not act to reverse the negative cumulative environmental effects on Fish Habitat, and therefore Fish.

The Status Quo will maintain the opportunity to trap beaver and muskrat in the impoundment, and the Waterfowl Habitat Restoration project will have positive cumulative environmental effects on freshwater wildlife as described for the Terrestrial Environment in Section 9.5.1.2.

The ERBFN is in strong support of removal of the dam and does consider the return to a natural estuary as providing more opportunity for Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons than is currently provided by the freshwater impoundment (*i.e.*, the trapping of muskrat and beaver). Therefore, the overall cumulative environmental effects of the Status Quo and other actions on Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons within the Assessment Area is considered to be negative and significant.

9.5.6.2 The Project

The Project will result in the restoration of traditional fish populations and the restoration of the saltmarsh that will provide opportunity for the restoration of traditional plant communities. The Village of Balmoral Sewage Aeration System will further improve fish habitat by reducing the input of nutrients into the estuary. As described for Fish and Fish Habitat in Section 9.5.1.1, Commercial Fishing will have negative environmental effects on fish (potentially significant on some species like Atlantic salmon), but the overall cumulative environmental effects on fish will be positive.

The Project will result in the loss of the freshwater wildlife habitat provided by the impoundment. The Waterfowl Restoration Project will offset approximately 0.50 ha by way of creation of new freshwater habitat in the region (near Tide Head).

Overall, in consideration of the views of the ERBFN as described above for the Status Quo, the loss of the freshwater habitat provided by the impoundment is considered as a not significant environmental effect that is necessary to achieve the very positive environmental effect of restoring the estuary on Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons. Therefore, the overall cumulative environmental effects of the Project in combination with the identified other actions on Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons within the Assessment Area are considered to be positive.

9.5.7 Tourism and Recreation

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Tourism and Recreation:

- Aboriginal Heritage Gardens; and
- Village of Charlo Tourism Development.

9.5.7.1 Status Quo

The Status Quo will not result in environmental effects on Tourism and Recreation, and therefore there are no cumulative environmental effects with other actions that may affect Tourism and Recreation.

9.5.7.2 The Project

The Project will result in increased recreation opportunity and increased tourism opportunity as a result of the restoration of the natural estuary. The Aboriginal Heritage Gardens will have very positive environmental effects on tourism opportunity that will overlap with those of the Project. The Village of Charlo Tourism Development will also have positive environmental effects on tourism opportunity within the Assessment Area. The overall cumulative environmental effects of the Project with those of other actions is therefore considered to be very positive within the Assessment Area.

9.5.8 Labour and Economy

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Labour and Economy:

- Aboriginal Heritage Gardens;
- Village of Charlo Tourism Development; and
- Commercial Fishing.

9.5.8.1 Status Quo

The Status Quo will not result in environmental effects on Labour and Economy, and therefore there are no cumulative environmental effects with other actions that may affect Labour and Economy.

9.5.8.2 The Project

The Project will result in a short-term labour need during Decommissioning, and improved economy and creation of jobs from long-term increases in tourism. These tourism-related cumulative environmental effects of the Project with the Aboriginal Heritage Gardens and the Village of Charlo Tourism Development are the same as those described for Tourism and Recreation (Section 9.5.1.5). In addition, local and regional commercial fishing may improve as Eel River based diadromous fish stocks and softshell clam quality improves as a result of the Project, providing increased revenue from the harvesting of there resources. Therefore, the cumulative environmental effects of the Project acting in combination with tourism-based actions and commercial fishing is anticipated to be positive on Labour and Economy in the Assessment Area.

9.5.9 Heritage and Archaeological Resources

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Heritage and Archaeological Resources:

- Aboriginal Heritage Gardens.

9.5.9.1 Status Quo

The Status Quo will not result in environmental effects on Heritage and Archaeological Resources, and therefore there are no cumulative environmental effects with other actions that may affect Heritage and Archaeological Resources.

9.5.9.2 The Project

The Project has the potential to result in an accidental disturbance to archaeological resources. Depending on the nature, extent and magnitude of the disturbed resource, the environmental effect could be significant, but this is considered very unlikely to occur as the Project is not anticipated to result in erosion or scouring of land beyond what existed prior to 1963. Development of the Aboriginal Heritage Gardens also has the potential to result in an accidental disturbance to archaeological resources that could similarly be significant, though unlikely. The cumulative environmental effect of the Project and the Aboriginal Heritage Gardens on Heritage and Archaeological Resources is therefore a slight increase to the risk of an accidental disturbance to archaeological resources, however this is still considered to be unlikely.

As part of the Follow-up and Monitoring Plan for Heritage and Archaeological Resources, the ERBFN (owners and operators of the Aboriginal Heritage Gardens) will be offered the opportunity to participate in monitoring for a potential disturbance to archaeological resources. In the unlikely event that archaeological resources are uncovered, the ERBFN would participate and the site could be incorporated into the Aboriginal Heritage Gardens. This would help to mitigate the accidental disturbance of the archaeological resource.

9.5.10 Public Health and Safety

The following actions have environmental effects that will overlap with those of the Status Quo and/or the Project on Public Health and Safety:

- Village of Balmoral Sewage Aeration System.

9.5.10.1 Status Quo

Under the Status Quo, significant environmental effects on water quality (bacteria) in the upper portion of the impoundment will continue, and the softshell clam fishery will remain closed due to potential bacterial contamination. The Village of Balmoral Sewage Aeration System will reduce the amount of bacteria entering the impoundment, thereby lowering bacterial contamination in the impoundment because the Village of Balmoral is the largest single contributor. However, the clam fishery is likely to remain closed (P. Godin, pers. comm.). Therefore, the cumulative environmental effects of the Project in combination with the Village of Balmoral Sewage Aeration System will continue to be significant on Public Health and Safety in the Assessment Area.

9.5.10.2 The Project

The Project will result in bacterial levels in the estuary that are within acceptable levels. The Village of Balmoral Sewage Aeration System will reduce the amount of bacteria entering the impoundment, thereby further lowering bacterial levels in the former impoundment area. Under the Project, the softshell clam fishery may be re-opened pending review by Environment Canada (Godin, pers. comm.). Therefore, the cumulative environmental effects of the Project in combination with the Village of Balmoral Sewage Aeration System will be positive on Public Health and Safety in the Assessment Area.

9.6 Recommended Mitigation for Potential Cumulative Environmental Effects

The cumulative environmental effects of the Project in combination with the other identified actions are positive for all VECs. Therefore, for Step 5, no mitigation is recommended in addition to that identified for the mitigation of environmental effects in the Project Description (Chapter 5) and the Environmental Effects Analysis (Chapter 7).

10.0 FOLLOW-UP PROGRAM

10.1 Requirements

As part of the EMP (Section 5.4), a Follow-up Program will be developed for the Project. The EIA Guidelines require that a well defined program of monitoring and follow-up initiatives regarding environmental effects resulting or potentially resulting from the Project (the "Follow-up Program") must be outlined in the EIA Report. The Guidelines require that the Follow-up Program include its objectives, content, implementation and reporting schedules, and each Follow-up Program is required to:

- establish baseline conditions;
- determine regulatory compliance (compliance monitoring);
- test the predictions of the EIA Report (environmental effects monitoring); and
- evaluate the effectiveness of measures used to mitigate environmental effects (environmental effects monitoring).

The Guidelines also require that the Follow-up Program include protocols to guide interpretation of monitoring and follow-up results and timely implementation of appropriate corrective actions.

The definition of "follow-up program" under Section 2(1) of *CEAA* means a program for:

- verifying the accuracy of the environmental assessment of a project; and
- determining the effectiveness of any measures taken to mitigate the negative environmental effects of the project.

As such, the Follow-up Program will be designed to meet the requirements of both the EIA Guidelines and *CEAA*.

A proposed Follow-up Program will be prepared for each phase of the Project (*i.e.*, Decommissioning and post-Decommissioning). It will consist of a detailed terms of reference including objectives, content, implementation and reporting schedules. The Follow-up Program will be filed with NBENV and provided to the public, stakeholders, and the ERBFN for review, prior to the commencement of Decommissioning activities. Feedback from these groups will be considered in finalizing the Follow-up Program. Should modification to the Follow-up Program be required throughout the course of each phase and subsequent review through adaptive management, the appropriate authorities will be notified and adjustments to the Program(s) will be made.

10.2 Recommendations

A discussion of the recommended follow-up and monitoring activities, if any, is provided below for each of the VECs that were considered in the EIA.

10.2.1 Atmospheric Environment

The negative environmental effects, if any, of the Project on the Atmospheric Environment, including Climate, Air Quality, Sound Quality, and Odour, are expected to be temporary, intermittent, of short duration, and confined to a local area. Given the nature of the Project, and the fact that the negative environmental effects of the Project on the Atmospheric Environment are rated not significant, no follow-up or monitoring is recommended.

10.2.2 Fish Habitat and Fish

During the Decommissioning phase and periods of high water flow the first year after Decommissioning, routine monitoring of suspended sediments will be conducted as necessary. Bacteria in water will also be monitored to determine if the shellfish harvesting area is improving. Sediment quality (*i.e.*, grain size) will also be assessed to verify EIA predictions by taking core samples in mudflat areas (including clam habitat) upstream and downstream of the current dam location 2, 5 and 10 years after Decommissioning. When sediment cores are taken, clam counts could also be carried out to assess clam populations (2, 5 and 10 years after Decommissioning).

10.2.3 Terrestrial Environment

Given the importance of individuals or communities of Species of Special Conservation Concern potentially affected by Project activities, it is recommended that a post-Decommissioning Follow-Up Program be developed for Migratory Birds focusing on Species of Special Conservation Concern. Follow-up should document habitat use and focus on changes in the occurrence of Species of Special Conservation Concern that may positively occur as a result of the Project. Follow-up with respect to wetlands and vegetation should focus on the re-establishment of saltwater marsh communities in the area of the impoundment and document the status of Species of Conservation Concern.

10.2.4 Migratory Birds

Changes are expected to be immediate and total, based on experience of the temporary draw down due to leaky stop logs last year. Changes in bird species use (*i.e.*, species present and behaviour) should be apparent in the year following the initial opening. It is expected the transition to marine shoreline habitat to proceed very quickly and it is likely that appropriate nesting behaviour should be evident in the first year following the initial opening. Therefore, spring and fall monitoring should be scheduled for two years following restoration of tidal flow. The purpose of this is to document shifts in bird species present and especially to identify breeding behaviour and document the fate of Species of Special Conservation Concern that are currently present, and document use by new Species of Conservation Concern.

10.2.5 Species at Risk

There is no recommended follow-up or monitoring specific to the Species at Risk VEC. However, observation of Species at Risk should be captured by the follow-up and monitoring recommended for the Terrestrial Environment (Section 10.2.3) and Migratory Birds (Section 10.2.4).

10.2.6 Water Resources

Given that the Project will intentionally restore estuarine conditions and remove the water supply provided by the DIWS, and the fact that these negative environmental effects of the Project on the Surface Water component of the Water Resources VEC are rated not significant, no follow-up or monitoring is recommended.

The Project will restore the tidal water flow in the current impoundment area to pre-dam conditions, and the existing water resources infrastructure in the Assessment Area has proved to be capable of withstanding these conditions. Further, the Project is not expected to result in environment effects on the Water Resources Infrastructure component of the Water Resources VEC. As such, no follow-up or monitoring is recommended.

10.2.7 Vessel Navigation

There is no recommended follow-up and monitoring specific to the Vessel Navigation VEC. Navigation conditions should be observed while conducting other follow-up and monitoring activities, such as those recommended for the Fish Habitat and Fish VEC (refer to Section 10.2.2).

10.2.8 Transportation Network

During Decommissioning, the negative environmental effects, if any, of the Project on the Transportation Network are expected to be minimal and of short duration, and are rated not significant. In addition, no loss of Level of Service (LOS) is anticipated as a result of the potential increase in tourism-related traffic during the post-Decommissioning phase. A loss in LOS would be highly unlikely given the large increase in volume of traffic that would be required to decrease the LOS from Level B to Level C. Therefore, there is no follow-up or monitoring recommended for the Transportation Network VEC.

10.2.9 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

A community-based study should be initiated to monitor the predicted positive changes to the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons as a result of the Project.

10.2.10 Tourism and Recreation

Follow-up and monitoring specific to the Tourism and Recreation VEC will include monitoring the southern shoreline of the estuary for signs of erosion. The environmental effects of the Project on recreational fish species and migratory birds will be monitored as described for those VECs, and as summarized in this chapter (Sections 10.2.2 and 10.2.4).

10.2.11 Labour and Economy

There is no recommended follow-up and monitoring specific to the Labour and Economy VEC. Other follow-up and monitoring relating to the restoration of conditions for softshelled clams and the provision of fish passage (Section 10.2.2) may be useful in determining the opportunity for improvements to commercial fishing in the Assessment Area.

10.2.12 Heritage and Archaeological Resources

Prior to the placement of rip-rap on the shoreline at Blueberry Point during Stage 1 of the Decommissioning phase, an archaeological assessment of the shoreline should be carried out. If any currently unknown archaeological sites are located along the erosional face of this point, the installation of the rip-rap could negatively affect these sites. It is also likely that a staging area will be created for Stage 2 of the Decommissioning phase, and therefore once the location for this area is confirmed, an archaeological survey and testing of this location will be required.

During Stage 3 of the Decommissioning phase, the water level in the current impoundment area is expected to revert rapidly to pre-dam level, and thus sections of newly exposed shoreline, floodplain and islands may be subject to erosion. Once water levels in the current impoundment area have decreased and ground conditions allow, it is recommended that all shoreline areas in the current impoundment and upriver portions that were flooded as a result of the dam undergo a comprehensive archaeological survey in order to determine the condition of Heritage and Archaeological Resources within the Assessment Area. If any archaeological sites are encountered during this survey, their condition will need to be evaluated in relation to the potential threat of erosion and from unauthorized digging and theft of artifacts once exposed.

If an unknown archaeological or heritage resource is encountered at any time during Decommissioning, all work should be stopped in the immediate area, and the Archaeological Services Unit should be contacted for guidance on the proper mitigation of the resource.

10.2.13 Public Health and Safety

It is recommended that a pre-Decommissioning geodetic survey program be carried out to confirm predictions that no infrastructure lies below 3.4 m proximal to the estuary.

It is recommended that a post-Decommissioning monitoring program be developed for fecal coliforms in the estuary to confirm the positive environmental effects that have been predicted. The monitoring program should be conducted 1 year and 3 years after the Project since major changes in this environment will probably occur relatively quickly after the removal of the dam, but would not have reached quasi-equilibrium necessarily in the first year. According to the modelling investigation, the estuary will approach equilibrium when the width of the tidal inlet reaches approximately 100 m, which is similar to that of pre-dam conditions and may take close to 10 years.

10.3 Implementation

Follow-up and monitoring activities will be carried out by qualified personnel and using standard protocols, as appropriate. Given the importance of the Project to the ERBFN community with respect to resource use and economic development, there may be opportunities for capacity building and employment within the Aboriginal Community that would support recent economic initiatives by the community (*e.g.*, Aboriginal Heritage Gardens, restoration of Heron Island). These opportunities could be achieved through involving members of the ERBFN community in the follow-up and monitoring activities recommended as part of the Follow-up Program. Mentorship with qualified personnel would ensure proper training for community members and integrity of monitoring.

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

11.0 SUMMARY AND CONCLUSIONS

11.1 Introduction

The Environmental Impact Assessment for Eel River dam was completed in accordance with the Guidelines issued February 27, 2004.

11.2 Project Objectives

The Project Objectives include (a) unimpeded and safe movement, upstream or downstream, of fish between aquatic habitats required to complete their life cycle; (b) establishment of conditions that lead to the natural re-establishment of salt marsh wetlands upstream of the current dam; and (c) improvement of habitat for softshelled clams and other shellfish upstream and downstream of the Eel River dam.

11.3 EIA Methods and Scope

The methodology used in this EIA was consistent with standard EIA methodological approaches. Three investigations were carried out to address data collection needs including: biophysical; socio-economic; and hydrodynamic, water quality and geomorphological. Several meetings were held in consultation with persons and organizations potentially affected by the Project. A media outlet, an Issues Tracking Log, an EIA study website and a toll-free number were set up for further communication with the public. Four public consultation meetings were carried out in an Open House format that included the attendance of community members, Elders, Chief and representatives of the Council of ERBFN, concerned citizens and stakeholders. Meetings with the ERBFN provided opportunities for meaningful discussion and input into the decision-making process. A summary of issues raised during public consultation meetings, stakeholder meetings and Aboriginal Community meetings can be found in Section 2.2.1.

11.4 Description of Existing Environment

A description of the existing environment, determined through field investigation and analysis of existing data, can be found in Chapter 3.

11.5 Evaluation of Existing Fishway and Potential Improvements to the Fishway Against the Project Objectives

Following evaluation, it was determined that modifications to the fishway structure would improve fish passage for some species at some times, but would not effectively achieve the fish passage Project Objective, nor would it address the other Project Objectives (Chapter 4). Therefore, it was decided that the dam be fully removed.

11.6 Project Description

The Project involves three stages. Stage 1 includes activities relating to design, acquisition of permits and communication, and implementation of shoreline protection, that must be carried out prior to creating the opening in the dam. During Stage 2, a 150 m-wide opening will be created in the north end of the dam, with the existing gates being used to control flows. Stage 3 involves removal of the remainder of the dam, which would be accomplished by excavating in a southerly direction from the initial 150 m opening. Stage 3 also includes removing the existing control structure.

11.7 Predicted Future Environment

The predicted future hydrodynamic, water quality and geomorphological conditions as a result of the removal of the Eel River dam are summarized in Chapter 6 and more detailed information contained in Appendix B.

The Project will result in an increased tidal prism in the Eel River estuary. It is expected that the opening at the tidal inlet will widen in response to the substantially increased tidal prism and related velocity increase and an opening of approximately 100 m will adequately restore this tidal prism. Effects of extreme tides, the predicted global warming effect and water level rise due to wind set-up were analyzed and it is conceivable that the area of the impoundment may be subject to additional flooding risk under both the Status Quo and the Project.

With respect to water quality, eutrophication in the impoundment will be alleviated over time, and the daily fluctuations of DO levels, characteristic of algal activities, will be substantially reduced. Increased dilution will result in decreased nutrient levels and the increased flushing of nutrients will make it unavailable for algal growth resulting in conditions in the estuary being considerably better than the pre-dam conditions. BOD loading from the Village of Balmoral is expected to be considerably oxidized prior to reaching Eel River estuary downstream and the accumulation of BOD in the substrate of the area of the impoundment is not expected to be great.

The removal of Eel River dam will result in saline tidal water migrating into the present impoundment area.

Erosive processes resulting from increased tidal flow will re-establish the pre-dam channel width to approximately 90 m at mid-tide elevation and the former channel on the north side of the estuary will likely be re-established as the dominant channel. The duration of erosion resulting from removal of the dam and the processes that will carry the eroded material away from the mouth of Eel Bay are also discussed.

Current ice conditions in the impoundment and how these conditions will differ with removal of the dam are described in ice regime. Frazil ice, and its effect on river environments, is also discussed.

11.8 Analysis of the Net Positive and Negative Effects of the Status Quo and the Project

A comparison of the net positive and negative effects of the Status Quo and the Project are outlined below.

11.8.1 Atmospheric Environment

11.8.1.1 Climate

The Status Quo and the Project are expected to result in negative environmental effects on Climate that are rated not significant. While the Project is expected to result in the release of some GHG emissions from the operation of vehicles/heavy equipment, these emissions would be temporary, intermittent, of short duration and confined to a local area, and subject to mitigation measures, and should not be discernible from current levels of GHG emissions at a local or regional scale. Similarly, any small and localized changes that may occur to the microclimate in the Assessment Area as a result of the Project are not expected to be discernible on local, regional, provincial, national or global scales. Finally, any losses of carbon sinks as a result of the Project would be relatively small on a regional scale, and likely offset by the enhancement or creation of new salt marsh habitat.

11.8.1.2 Air Quality

The Status Quo and the Project are expected to result in negative environmental effects on Air Quality that are rated not significant. While some air emissions would be released during the operation of vehicles/heavy equipment for the Project, these emissions would be intermittent, of short duration, confined to a local area, and subject to mitigation measures. Any emissions released should not be discernible from current emission levels on a local or regional scale.

11.8.1.3 Sound Quality

The Status Quo and the Project are expected to result in negative environmental effects on Sound Quality that are rated not significant. While some sound would be produced during the operation of vehicles/heavy equipment for the Project, the resulting sound pressure levels would be temporary, intermittent, of short duration, confined to a local area, and subject to mitigation measures.

11.8.1.4 Odour

The Status Quo and the Project are not expected to result in negative environment effects on Odour. The Project may have a positive environmental effect on Odour with respect to any lingering odour emissions related to the former sewage lagoon outfall, with the restoration of flow in Eel River and tidal flushing in the current impoundment area.

11.8.2 Fish Habitat and Fish

11.8.2.1 Fish Habitat

The Status Quo will continue to result in negative environmental effects on Fish Habitat. The fishway structure will continue to impede fish passage, and thus the fish passage Project Objective will not be achieved. Further, water quality concerns with respect to the abrupt transition from near-marine salinity to freshwater conditions, high water temperatures, and eutrophication and low DO concentrations, will persist in the current impoundment area. Finally, sediment quality issues involving grain size and lack of suitable softshelled clam habitat will persist in the estuary below the dam, and thus the Project Objective of improving habitat for softshelled clams and other shellfish will not be achieved.

In contrast, the Project will result in positive environmental effects on Fish Habitat. The Project will rectify the fish passage issue, and thus the fish passage Project Objective will be achieved. All of the current water quality concerns will be rectified, through the restoration of the free-flow of tidal waters and twice daily flushing of the current impoundment area. In addition, the sediment quality issues will be rectified with the restoration of mudflats similar to pre-dam conditions. Subsequently, softshelled clam stocks will have the opportunity to replenish and the Project Objective of improving habitat for clams and other shellfish will be met. Although accumulated sediments may be released to the current Eel River estuary and Eel Bay as a result of the Project, the amount of sediments released is not expected to be substantial, and any negative environmental effects will be short in duration and are predicted to be not significant.

11.8.2.2 Fish

The Status Quo will continue to result in negative environmental effects on Fish, as the fishway will continue to prevent native anadromous fish species from accessing the Eel River to complete their life cycle; softshelled clams and other shellfish will remain absent from the current freshwater impoundment area; and softshelled clam stocks will continue to be poor in the unsuitable habitat of the estuary below the dam. In contrast, the Project will result in positive environmental effects on Fish, with the restoration of the free-flow of tidal waters and the potential for the re-establishment of native fish species and clams to pre-dam conditions in the Assessment Area.

11.8.3 Terrestrial Environment

11.8.3.1 Wetland and Vegetation

11.8.3.1.1 Wetland

Under the Status Quo, wetland habitat in the impoundment may be expected to be stable in the current condition for the foreseeable future. While there is a small amount of salt marsh (1.0 ha) in the estuary below the dam, construction of the dam resulted in a significant loss of wetland and salt marsh area. This loss will continue under the Status Quo and will not result in a net increase in wetland area towards that which existed before the dam was constructed. Therefore, the environmental effects on wetlands under the Status Quo are rated significant.

The Project will result in a net increase in wetland and salt marsh areas that will be at or close to that which existed prior to the construction of the dam. Therefore, the environmental effects of the Project on wetlands are rated positive.

11.8.3.1.2 Vegetation

Under the Status Quo, common natural vegetation in the wetland and shoreline habitat will remain stable; however, the invasive species Purple Loosestrife and Flowering Rush will continue to spread and eventually dominate the wetland and shoreline habitat in the impoundment. Tufted Loosestrife, Water-flaxseed and Marsh Horsetail are adapted to freshwater habitats and under the Status Quo, no significant change in these plant populations is expected.

The Project will severely reduce or eliminate the current invasive species populations from the lower impoundment area. This is a benefit of the Project given that these species negatively affect the native vegetation. The Project will probably reduce or eliminate the populations of Tufted Loosestrife, Water-flaxseed and Marsh Horsetail from the area of the impoundment following dam removal. Since these species are considered Secure in NB and are likely to occur in freshwater habitats upstream along Eel River and in the surrounding region, this residual environmental effect is considered not significant. Lesser Panicled Sedge is recorded at sites along northern and eastern coastlines and may be able to tolerate tidal conditions in the estuary. This species in particular will require monitoring to ensure any unanticipated significant negative environmental effects are detected. Estuary Sedge and Cursed Crowfoot are adapted to coastal habitats and are capable of tolerating tidal conditions in the estuary. Therefore, long-term survival of both populations is expected to be unaffected and this residual environmental effect is considered not significant.

Overall, it is not expected that the Project will result in direct mortality of individuals or communities of Species of Special Conservation Concern to such an extent that such communities would reduce the likelihood of the long-term survival of regional populations. Moreover, the creation of locally uncommon salt marsh will improve opportunities to establish communities of Species of Special Conservation

Concern and improve local and regional biodiversity. Therefore, the environmental effects of the Project on Species of Special Conservation Concern are rated not significant, and may be positive.

11.8.3.2 Wildlife

It is expected that regional populations of common wildlife in the Assessment Area will remain stable under the Status Quo and the Project. During Stage 2 and 3 of Decommissioning, common wildlife populations in wetland and shoreline habitats of the impoundment will undergo change in response to restored tidal flow as the habitat is transformed from a freshwater habitat to an estuary. This will cause wildlife species dependant on freshwater habitat to move out of the area of the impoundment, while species dependant on saltwater habitat may move in. Freshwater habitat will continue to be available upstream along the Eel River and elsewhere in the surrounding region for any wildlife species displaced by the change in habitat type, including muskrat and beaver. Therefore, no significant effects on wildlife species from Project activities are expected.

No Species of Conservation Concern are known to occur in the Assessment Area, therefore, no significant effects from the Status Quo or the Project are expected.

11.8.4 Migratory Birds

The Status Quo will continue to provide a freshwater habitat for the Migratory Birds that frequent the impoundment area. Therefore, the environmental effects of the Status Quo are rated not significant.

The Project will result in a net increase in salt marsh area and provide habitat for a range of Migratory Birds that frequented the Assessment Area prior to construction of the dam. As evidenced by the leaky stop logs, the transition from freshwater to saltwater habitat will be conducive for such species as the Semipalmated Plover and possible Species of Special Conservation Concern, identified at risk and endangered under both the Federal and Provincial jurisdictions. Therefore, the environmental effects on the Project on Migratory Birds are rated not significant and may be positive.

11.8.5 Species at Risk

Since no critical habitat for Species at Risk has been identified in the impoundment or adjacent areas, no substantial environmental effects will occur. Potential environmental effects on habitat for Species at Risk overall will likely be beneficial with the removal of the dam due to restoration of estuarine and salt marsh habitat.

11.8.6 Water Resources

11.8.6.1 Surface Water

The Status Quo is not expected to result in environment effects on the Surface Water component of the Water Resources VEC, given that the DIWS is already an inadequate source of water supply for industrial or municipal use. The water quality in the Eel River impoundment is declining, high costs are associated with operating and maintaining the DIWS (and which would be borne by NB Power, the only remaining user of the system), and a contractual agreement exists between NBENV and the ERBFN for the removal of the dam.

The Project is expected to result in a negative environmental effect on the Surface Water component of the Water Resources VEC that is rated not significant. The removal of the Eel River dam may result in the loss of immediate water supply to the NB Power generating station. Given the fact that this water supply is already inadequate, may continue to infringe upon Aboriginal interests protected under the *Constitution Act* and *Fisheries Act*, and potential alternate water supply sources are available to NB Power, this negative environmental effect is rated not significant.

11.8.6.2 Water Resources Infrastructure

The Status Quo is not expected to result in environment effects on the Water Resources Infrastructure component of the Water Resources VEC, since the Charlo River water supply watermain has proved to be capable of withstanding the existing conditions in the current Eel River impoundment area. Likewise, the Project is not expected to result in environment effects on the Water Resources Infrastructure component of the Water Resources VEC. The Project will restore the tidal water flow in the current impoundment area to pre-dam conditions, and the watermain has proved to be capable of withstanding these conditions as well. Planned mitigation during construction will prevent scour and erosion of the Charlo River water supply watermain.

11.8.7 Vessel Navigation

The Status Quo will continue the proliferation of aquatic vegetation and will maintain the complete obstruction to vessel passage at the dam. In contrast, the Project will restore the pre-dam estuarine conditions, thereby eliminating the aquatic vegetation problem, and the dam obstruction will be removed. This will restore contiguous navigation opportunity from the Village of Eel River Crossing to Eel Bay.

Current use of the impoundment for navigation is limited, and during repeated field visits during the summer of 2005, the Jacques Whitford Study Team did not observe any recreational boating activity. Recently, there has been an increasing interest in nature based tourism and recreation activities, including canoeing and kayaking. The Project will result in improved opportunity for these activities as the natural estuarine tide and river flow conditions will be restored. Overall, the Project is therefore considered to result in a positive environmental effect on Vessel Navigation, while the Status Quo will result in neutral to negative environmental effects on Vessel Navigation.

11.8.8 Transportation Network

The Status Quo will not act (under normal operating conditions) to change the current LOS or traffic levels on the roads within the Assessment Area. The Status Quo will not change the rate at which the existing Transportation Network infrastructure is aging and/or being damaged by erosion. The Project will result in a short-term measurable increase to traffic levels during Stage 2 and Stage 3 of the Decommissioning Period. However, this will not cause a loss of LOS, and the increased traffic will be temporary. The Project may also indirectly result in some minor long-term increases to traffic levels as the number of tourists attracted to the Assessment Area increases as a result of the restoration of the natural estuary.

11.8.9 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

The Status Quo is anticipated to perpetuate, and potentially increase, the reported significant negative environmental effects to the Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons that have resulted since the construction of the Eel River dam.

The Project is predicted to have substantially positive environmental effects on Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons since it is anticipated to reverse the current river and shoreline conditions that have resulted in the decreased availability of the land and resources. The restoration of fish passage and tidal exchange will likely improve fish stocks, clam beds, the presence of important plant species, and increase opportunities for recreational use in the surrounding watercourse. Due to all these factors, the cultural and resource use opportunities for the ERBFN are predicted to increase.

11.8.10 Tourism and Recreation

The Status Quo is expected to maintain, but not increase, the current level of tourism and recreation activity and opportunity within the Assessment Area. The environmental effects of the Status Quo are anticipated to be neutral.

The Project is anticipated to provide increased opportunity for vessel-based recreation, recreational fishing, bird-watching, swimming, and increased potential for the attraction of tourists to the Aboriginal Heritage Gardens, and consequently other tourism-based services. The overall environmental effects of the Project are anticipated to be positive.

11.8.11 Labour and Economy

Both the Project and the Status Quo will result in the short-term (approximately 2 years) creation of labour opportunity and need for goods and services. Therefore, they will both result in some positive environmental effects in the short-term on Labour and Economy.

The Status Quo is not anticipated to result in any other changes to labour opportunity or economic benefits beyond those associated with the short-term work to replace or repair the existing infrastructure. The Project will result in indirect positive changes in labour opportunity and economic benefits over the longer term, such as those associated with the operation of the Aboriginal Heritage Gardens and commercial fishing. Therefore, the environmental effects of the Project over the long-term are considered to be positive, while those of the Status Quo are considered to be neutral (*i.e.*, no change from present conditions).

11.8.12 Heritage and Archaeological Resources

Once the water levels in the current impoundment area have decreased following the removal of the dam, and ground conditions allow, it is recommended that a comprehensive archaeological survey and testing be conducted by a professional archaeologist to determine the condition of any archaeological and heritage resources present within the assessment area. The Status Quo can be expected to cause minimal damage or destruction to the historic shorelines (*i.e.*, pre-dam shorelines) of Eel River, through continued erosion along the southern shoreline of the impoundment. The potential negative environmental effects of the Status Quo on Archaeological and Heritage Resources, in consideration of the residual environmental effects significance rating criteria, are likely to be not significant, but may be significant due to a disruption of currently unknown resources.

The Project may result in the return of pre-dam water levels in the impoundment area and in some sections of the river that are currently flooded. If this occurs, then any archaeological sites that are located along the currently submerged shorelines have the potential to be exposed, and possibly eroded. The installation of erosion control material around Blueberry Point after the first stage of the Project will require an archaeological survey and testing to determine if there are any resources present at that location. It is recommended that the ERBFN be invited to participate in all archaeological work.

If substantial erosion of the newly exposed shorelines and islands is likely following the removal of the dam, then it is recommended that a comprehensive archaeological survey and testing be conducted by a professional archaeologist to determine the condition of any archaeological and heritage resources present within the Assessment Area. In addition, the planned future uses of this reclaimed land should be considered.

In consideration of the probability of occurrence and the proposed mitigation, the potential environmental effects on Archaeological and Heritage Resources from the Project are predicted to be not significant.

11.8.13 Public Health and Safety

11.8.13.1 Flooding and Flood Risk

The risk of flooding for the Project is not considered to be higher than the Status Quo. The dam under the Status Quo does provide some protection from extreme tides and storm surge, but can also contribute to upstream flooding because of water retention by the dam during spring runoff and high precipitation events and the inefficiencies of manual intervention in monitoring and operating the gates of the dam. The Project does not provide flooding protection to extreme water levels and long-term sea level rise. However, any extreme rise in water level will be short in duration and in terms of a few hours, and recede with the falling tide. If on the long term sea level rise is substantial for both the Status Quo and the Project, where the water level could increase (extreme estimate) up to 0.88 m by about 2100, this will not reach the design elevation for the impoundment of 3.4 m. In contrast to the Status Quo, with the Project there is less risk of flooding attributed to ice jams, spring runoff and high rainfall. Overall, both the Status Quo and the Project will result in flooding and flood risk that will result in environmental effects on Public Health and Safety that are rated not significant.

11.8.13.2 Bacteriological Environment

Under the Status Quo, it is expected that the bacteriological environment upstream of the impoundment in Eel River and in the estuary below the dam will remain stable with higher levels of fecal coliforms compared to the Project. This is a result of the presence of the dam itself, and sediment infilling of the estuary and narrowing of the tidal inlet attributed to the construction of the dam. The reduced tidal volume and flow has resulted in the reduction of flushing capacity of the estuary below the dam and a longer residence time of the water upstream as a result of retention by the dam. These factors for the current conditions have contributed to inadequate flushing of fecal coliforms from the river and from the estuary below the dam that would continue under the Status Quo (Section 7.13.3.2.2). The bacteriological environment for the Project will improve compared to the Status Quo because of restored tidal flow and exchange. This restored flow throughout the length of the full estuary will deepen the lower reaches of the estuary and widen the tidal inlet, which will result with an increased tidal volume and flow, contributing to a more effective tidal exchange and flushing of fecal coliforms in the water. This improvement will be a more positive environmental effect for the Project in the lower reaches of the estuary because of the higher tidal volume and flushing of fecal bacteria that occur in this area and because of the waterfowl. The Project will also improve concentrations of fecal coliform upstream in the Eel River because river flow will be restored with little or no stagnation of water (*i.e.*, no standing water) to promote bacterial growth and survival times.

11.8.13.3 Food Resource Contamination

The potential for bioaccumulating chemicals in food resources will be higher for the Status Quo in comparison to the Project because of the reduced tidal flow and volume and therefore longer contact period with contaminants by organisms under the Status Quo.

The possibility of lifting the ban on shellfish growing areas in the Assessment Area is more likely with the Project in comparison to the Status Quo. This is a result of the recent sampling by Environment Canada that suggests fecal coliforms were not reduced in the estuary and despite the decommissioned sewage outfall of the Village of Eel River Crossing for the Status Quo. There is a higher probability that once the dam is removed, the bacteriological water quality in the shellfish growing areas of the Assessment Area may improve and which would justify re-evaluation by Environment Canada (Godin, pers. comm.). This will not occur under the Status Quo because of the lack of improved sanitary conditions in the estuary that is being attributed to the waterfowl present in this area and the reduced flushing capacity of the estuary with the Status Quo (Section 7.13.3.2.2).

Overall, the Project will result in environmental effects that are positive on Public Health and Safety. This is a result of improvements with respect to bioaccumulating chemicals and fecal coliform contamination in the estuary, compared to the current conditions, to levels that will likely meet applicable standards (*Canadian Food and Drugs Act* and Environment Canada bacteriological water quality standards for consumption of shellfish).

11.8.14 Accidents, Malfunctions and Unplanned Events

Potential accidents, malfunctions and unplanned events have been assessed and, for the majority, they are not significant. Water Resource Infrastructure includes mitigation planned during construction to prevent scour and erosion of the Charlo River water supply watermain as such an event, although not likely, could result in a significant environmental effect by interrupting supply to water users. The Project has the potential to result in an accidental disturbance to Archaeological Resources. Depending on the nature, extent and magnitude of the disturbed resource, the environmental effect could be significant, but this is considered very unlikely to occur, as the Project is not anticipated to result in erosion or scouring of land beyond what existed prior to 1963. If an unknown archaeological or heritage resource is encountered during construction, then all work should be stopped in the immediate area, and the Archaeological Services Unit should be contact for guidance on the proper mitigation of the resource.

11.9 Effects of the Environment on the Project

The aspects of the environment that may cause a change in the Status Quo or Project include the following: sediment transport process; tidal prism; weather; flooding; ice; climate change; and earthquake activity. A significant negative effect of the environment on the Status Quo or Project would result in damage to Status Quo or Project infrastructure, or loss of schedule, resulting in a long-term interruption in service or repairs that could not be technically or economically implemented. Failed mitigation causing environmental damage that could not be technically and economically corrected or compensated in a feasible manner would also be a result of a significant negative effect of the environment.

Engineering planning and design always involves consideration of the effects of the environment on a project, and the planning and engineering design for this Project are no exception. However, the Project is an environmental restoration effort, and does not involve permanent infrastructure. In this regard, the Project is not particularly sensitive to effects from the environment. In contrast, the Status Quo does include the dam and control structure infrastructure, and is sensitive to effects from the environment.

The sediment transport process, tidal prism, flooding, and the weather have the potential to affect Stage 2 of the Project. However, the rock wall barrier will minimize and control flow velocities to prevent excessive scour and provide a safe working environment during Decommissioning. All effects of the environment on the Project will be limited to the Decommissioning period and are therefore temporary.

By contrast, the effects of the environment on the Status Quo will likely persist in the form of sediment plugs, ice jams, and potential need for retrofitting as a result of climate change and sea level rise.

11.10 Cumulative Environmental Effects Analysis

A total of five future actions were identified that may have environmental effects that overlap in time and space with those of the Project and/or Status Quo. Of the identified actions, the Aboriginal Heritage Gardens, the Village of Balmoral Sewage Aeration System and Commercial Fishing were determined to have the most likely, most direct, and greatest (in magnitude) potential cumulative environmental effects with the Project and the Status Quo.

The Status Quo, in combination with the other identified actions, will continue to result in significant cumulative environmental effects on Fish Habitat and Fish, Terrestrial Environment, Migratory Birds, Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons, and Public Health and Safety. The Status Quo would continue to have some positive cumulative environmental effects on fish and wildlife species (including birds) that prefer the freshwater environment provided by the impoundment, but not to the extent that the overall cumulative environmental effects on those VECs could be considered positive.

The Project, in combination with the other identified actions (primarily the Aboriginal Heritage Gardens), will result in positive cumulative environmental effects on Fish Habitat and Fish, Terrestrial Environment, Migratory Birds, Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons, Tourism and Recreation, Labour and Economy, and Public Health and Safety. The Project will result in some negative cumulative environmental effects (with tourism-related actions) that are not significant on the Transportation Network. There is no additional mitigation recommended to address cumulative environmental effects beyond that required as specified in the Project Description (Chapter 5) and the Environmental Effects Assessment (Chapter 7).

11.11 Follow-up and Monitoring Program

As part of the EMP (refer to Section 5.4), a Follow-up Program will be developed for each phase of the Project (*i.e.*, Decommissioning and post-Decommissioning) and designed to meet the requirements of the EIA Guidelines and *CEAA*. It will consist of a detailed terms of reference including objectives, content, implementation and reporting schedules, based on the recommended follow-up and monitoring activities (if any) for each of the VECs assessed in the EIA. The Follow-up Program will be filed with NBENV and provided to the public, stakeholders, and the ERBFN for review, prior to the commencement of Decommissioning activities. There may be opportunities for capacity building and employment within the ERBFN community through involving members of the community in the recommended follow-up and monitoring activities.

11.12 Overall Conclusion

The Status Quo does not meet the Project Objectives, whereas the Project does. The Status Quo will result in significant environmental effects on the following components: Fish Habitat and Fish; Wetlands; Vessel Navigation; Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons; Heritage and Archeological Resources (not likely); and Public Health and Safety (Bacteriological Environment and Food Resource Contaminiation).

The Project will result in significant environmental effects that may be positive on the following components: Wetlands; Vegetation; Migratory Birds; Vessel Navigation; Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons; Tourism and Recreation; Labour and Economy; and Bacteriological Environment.

Finally, the Project will result in positive environmental effects on Fish Habitat and Fish. The Project will rectify the fish passage issue, and thus the fish passage Project Objective will be achieved. All of the current water quality concerns and sediment quality issues will be rectified. Softshelled clam stocks will have the opportunity to replenish and the Project Objective of improving habitat for clams and other shellfish will be met.

<THIS PAGE IS INTENTIONALLY LEFT BLANK>

12.0 REFERENCES

12.1 Personal Communications

Ayles, R.	Transportation Maintenance Superintendent, Tide Head Office, District 1, NBDOT, 2006.
Albert, F.	Canadian Food Inspection Agency, Sippagan Distric Office. 2005
Balon, E.	Fisheries Biologist, Guelph University, Guelph, Ontario.
Bell, G.	AMEC January 17, 2006
Bérubé, D.	Geological Surveys Branch, New Brunswick Department of Natural Resources. July 25, 2005.
Bielecki, A.	NB Power. January 17, 2006.
Bujold, K.	Administrator, Village of Eel River Crossing, December 2004.
Chaput, G.	DFO, Section Head, Diadromous Fish Section, Gulf Fisheries
Clifford, J.	Restigouche Naturalists Club,
Forbes, D.	Program Manager, Reducing Canada's Vulnerability to Climate Change. Earth Sciences Sector, Bedford Institute of Oceanography, Dartmouth, Nova Scotia. August 11, 2005.
Fox, D.	Water Quality Unit, NBDELG, pers. comm. 2006
Godin, P.	Environment Canada, 2005
Goulette, A.	Administrator, Village of Charlo, New Brunswick,
Guitard, E.	Public Works Superintendent, Town of Dalhousie. 2005
Guitard, E.	Public Works Superintendent, Town of Dalhousie. January 16, 2006.
Haché, D.	DFO, Stewardship Section, Moncton, New Brunswick.
Hodgson, B.	Local birdwatcher,

Hubley, P.	Former DFO Engineer.
Jacques, T.	Campbellton Tribune, New Brunswick, December 2004.
Jean, G.	Assistant District Engineer, District 1, New Brunswick Department of Transportation.
Kingston, C.	Acting Water Dept. Supervisor, Town of Dalhousie, March 17, 2005.
LeBlanc, T.	Manager, Waste Management/Environment and Local Government. Fredericton, New Brunswick. January 17, 2005; December 2005; January 9, 2006.
Letourneau, A.	Local birdwatcher.
Lushington, M.	Local birdwatcher.
Madden, A.	Fisheries and Wildlife Specialist and former Regional Biologist, NBDNR Region 1, Tide Head, New Brunswick.
Martin, T. E.	ERBFN Chief, 2004
McCluskey, B.	New Brunswick Trails Council Inc.
McNair, R.	Department of Fisheries and Oceans.
Morin, G.	Meteorological Services of Canada, Atlantic Climate Centre, Fredericton, New Brunswick.
Pelletier, B.	Forest Ranger IV, NBDNR.
Quigley, T.	Local angler.
Reinsborough, K.	Local resident.
Robichaud, J.	Public Works. January 12, 2006.
Ross, K.	Local birdwatcher.
Tardif, A.	Engineer, Hospital Services Branch of the New Brunswick Department of Dalhousie Health & Wellness. November 9, 2005.
Theriault, S.	NBDELG: 2005 12 13

12.2 Literature Cited

AC CDC (Atlantic Canada Conservation Data Centre). 2003. Provincial Lists and Ranks. Internet Publication: http://www.accdc.com/products/lists/. Last updated: 24/02/2003.

ACOA (Atlantic Canada Opportunities Agency) website. 2003. Aboriginal Economic Development in Atlantic Canada: Part 4 - Building the Future: Stories of Successful Aboriginal Communities. http://www.acoa.ca/e/library/reports/aboriginal/

ADI, 2003. Identification of a Realistic Provincial Standard Noise Threshold Level. Prepared by ADI Limited for the New Brunswick Department of Transportation. Report: (55) 0600-454, April 1, 2003.

Alexander, R. McN. 1974. Functional Design in Fishes. Hutchinson University Library. 160 p.

Atlantic Canada Opportunities Agency (ACOA). 2003. Building the Future: Stories of Successful Aboriginal Communities. Accessed online on January 5, 2006 at http://www.acoa.ca/e/library/reports/aboriginal/BuildingA.shtml.

BMA (Boissonnault McGraw & Associates Ltd.). 2001. Study of Regional Water and Wastewater Treatment Systems (Dalhousie, Eel River Bar First Nation and Eel River Crossing). Project no. 1879. Campbellton, NB. 49 pp.

BMA (Boissonnault McGraw & Associates Ltd.). 1998. Supplement to Study of Eel River Pumping Station. Project no. 96-251. Campbellton, NB. 6 pp.

BMA (Boissonnault McGraw & Associates Ltd.). 1996. Study for the Eel River Pumping Station and Regional Water System Interconnection. Prepared for New Brunswick Department of the Environment. Project 96-254. December 1996.

BMA and CS&G (Boissonnault McGraw & Associates Ltd. and CH2M Gore & Storrie Limited). 2000. Assessment of the Impact of Removing the Eel River Dam on the Development of Environmental, Economic, and Social Benefit from Eel River. Prepared for Province of New Brunswick Department of the Environment. January 2000.

Bowater. 2005. Our History. Accessed online on January 6, 2006 at http://www.bowater.com/en/history.shtml.

Bowater. 2004. Minutes of meeting with Bowater Maritimes Inc. Bowater Boardroom, Dalhousie, New Brunswick. December 08, 2004.

Bowyer, P.J. 1995. Where the Wind Blows. Minister of Public Works and Government Services Canada, 1995, pp 178.

Bradford, R.G., G. Chaput, S. Douglas, and J. Hayward. 2001. Status of Striped Bass (*Morone saxatilis*) in the Gulf of St. Lawrence in 1998. Can. Stock. Assess, Secr, Res. Doc. 2001/006.

Bradford, R.G. and G. Chaput. 1996. Status of Striped Bass (*Morone saxatilis*) in the Southern Gulf of St. Lawrence in 1995. DFO Atl. Fish. Res. Doc. 96/62.

Bray, D. I. and Xie, H., 1993. A Regression Method for Estimating Suspended Sediment Yields for Ungauged Watersheds in Atlantic Canada. Canadian Journal of Civil Engineering, Vol. 20, No. 1, 82-87.

Bruun, P. and Gerritsen, F., 1955. Stability of coastal inlets. North-Holland Publishing Company, Amsterdam. 123 p.

Burke, K.B.S. 2004. Earthquakes Canada: Earthquake Activity in New Brunswick. Natural Resources Canada. http://www.seismo.nrcan.gc.ca/significant_eq/nbrunswick/ nbrunswick_e.php

Campbellton Tribune, November 19, 2003

Canadian Hydrographic Service. 1965. Data compilation; Belledune Point Current Survey, 1964 unpublished manuscript. BIO data series report 65-1.

CCME (Canadian Council of Ministers of the Environment). 2003a. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Online: http://www.ccme.ca/assets/pdf/e1_062.pdf

CCME (Canadian Council of Ministers of the Environment). 2003b. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Online: http://www.ccme.ca/assets/pdf/e1_062.pdf

CCME (Canadian Council of Ministers of the Environment). 1998. Recreational Water Quality Guidelines and Aesthetics. In: Canadian Environmental Quality Guidelines, 1998, Canadian Council of Ministers of the Environment, Winnipeg.

CH2M (CH2M Gore & Storrie Limited). 1998. Memorandum: Progress Report and Projected Schedule for Environmental Development Plans for the Eel River Head Pond. February 26, 1998.

CIRRD (Canadian Institute for Research on Regional Development). 1996. The Economic Region of Northeast New Brunswick. Internet Publication: http://www.umoncton.ca/icrdr/index_icrdr.html

Clancy, P. and L.A. Sandberg. No date. The Acadian Forest - Forest Industry and Economy: Maritime Pulp and Paper Firms. St. Francis Xavier University, Antigonish, Nova Scotia. Accessed online on January 6, 2006 at http://www.stfx.ca/academic/political-science/acadian-forestry/MaritimeP&PFirms.htm.

Clay, C.H. 1995. Design of Fishways and Other Fish Facilities – 2nd edition. 248 p.

Davies, J.L., 1977. Geological Map of Northern New Brunswick. Department of Natural Resources. Map NR-3.

DFO (Department of Fisheries and Oceans). 2004. Fisheries Statistics. Diadromous Fish Division, Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS.

DMTS (Department of Mines and Technical Surveys). 1962. Analysis of Water Sample(s) at Eel River. Analysis conducted by DMTS for the New Brunswick Water Authority.

Environment Canada. 2004a. Raw Data – Temperature and Precipitation Averages and Extremes, Campbellton Meteorological Station, 1945-1963. Data obtained from Gerard Morin, Meteorological Services of Canada, Atlantic Climate Centre, Fredericton, New Brunswick, on March 10, 2005.

Environment Canada. 2004b. Canadian Climate Normals 1971-2000. Charlo Airport Meteorological Station. Electronic data obtained from the Environment Canada National Climate Data and Information Archive on March 9, 2005. Internet Publication: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/

Environment Canada. 2004c. The Climate of New Brunswick. Internet Publication: http://www.atl.ec.gc.ca/climate

Environment Canada. 2003a. Canada's Greenhouse Gas Inventory 1990-2002. Internet Publication: http://www.ec.gc.ca/pdb/ghg

Environment Canada. 2003b. Consensus Forecasts for Criteria Air Contaminants 1990-2010. Criteria Air Contaminants Division. Internet publication: http://www.ec.gc.ca/ pdb/pa/pa_cons_e.cfm.

Environment Canada. 1999. 1995 Criteria Air Contaminant Emissions for Canada. Pollution Data Branch. December 1999. Internet Publication: http://www.ec.gc.ca/pdb/ape/

Environment Canada. 1997. Climate Change and Climate Variability in Atlantic Canada. Volume VI of the Canada Country Study: Climate Impacts and Adaptation.

Environment Canada. 1987. New Brunswick Wetlands Atlas. Wetlands Protection Mapping Program. Canadian Wildlife Service Atlantic Region.

ERBFN (Eel River Bar First Nation). 2005a. March 10, 2005. Minutes of Meeting with Eel River Bar First Nation. Eel River Bar First Nation Community Building, Eel River, N.B.

ERBFN (Eel River Bar First Nation). 2005b. August 02, 2005. Minutes of Meeting with Eel River Bar First Nation. Eel River Bar First Nation Community Building, Eel River, N.B.

ERBFN (Eel River Bar First Nation). 2004. November 16, 2004. Minutes of Meeting with Eel River Bar First Nation. Eel River Bar First Nation Community Building, Eel River, N.B.

ERBFN (Eel River Bar First Nation). 1997. Memorandum: Subject: Headpond – RFP. From Time Dedam, To: Chief and Council. Environmental Development Plan for the Eel River Headpond. Proposed Study Terms of Reference. Draft #3, April 24, 1997. May 12, 1997.

FAO and DVWK (Food and Agriculture Organization of the United Nations and Deutscher Verband fur Wasserwirtschaft und Kulturbau e.V.). 2002. Fish passes – design, dimensions and monitoring. 118 p.

Ganong, W.F. 1899. A Monograph of Historic Sites in the Province of New Brunswick, Transactions of the Royal Society of Canada, 2nd series 5(2): 213-257.

Geological Survey of Canada. No Date. Surficial Geology Map of New Brunswick.

Government of Canada. 2005. *Species at Risk Act* Public Registry. Online: http://www.*SARA*registry.gc.ca/default_e.cfm

Government of Canada. 1999. National Ambient Air Quality Objectives. Canadian Environmental Protection Act, Schedule 1, 1999. Available online at http://www/hc-sc.gc.ca/hecs-sesc/air_quality/naaqo.htm

Government of New Brunswick. 2004. Department of Finance, Government of New Brunswick. Electronic data from Population Estimates for New Brunswick Census Divisions. Accessed on March 8, 2005. Internet Publication: http://www.gnb.ca/0160/Economics

Government of New Brunswick. 1997. Air Quality Regulation. New Brunswick Regulation 97-133 filed under the Clean Air Act, Government of New Brunswick, 1997.

Gregory, D., B. Petrie, F. Jordan, and P. Langille. 1993. Oceanographic, Geographic and Hydrological Parameters of Scotia-Fundy and Southern Gulf of St. Lawrence Inlets. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 143.

Hilderbrand, L. P. 1984. An Assessment of Environmental Quality in the Baie des Chaleurs. Environmental Protection Service Report EPS-5-AR-84-8, Environment Canada. 191 p.

Hinds. 2000. The Flora of New Brunswick, 2nd. Ed.

Hood and Associates (D.J. Hood and Associates Ltd.). 2000. Issues Scoping Exercise Removal of Eel River Dam. Prepared for NBDELG, Fredericton, New Brunswick.

Indian Claims Commission. 1997. Eel River Bar First Nation Inquiry. Report On: Eel River Dam Claim. December 1997.

IPCC (Intergovernmental Panel on Climate Change). 2001. Climate Change 2001: The Scientific Basis. http://www.grida.no/climate/ipcc_tar/wg1/index.htm

Jacques Whitford. 2003. Eel River Crossing Aquatic Environment Surveys. Letter report to Boissonnault McGraw and Associates for the Village of Eel River Crossing. December 5, 2003. 5 p and 4 appendices.

Jones, D.S., G.W, Suter and R.N. Hull. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. Prepared for the U.S. Department of Energy. ES/ER/TM-95/R4.

Katopodis, C. 1992. Introduction to Fishway Design. Freshwater Institute, Central and Arctic Region, Fisheriens and Oceans Canada, Winnipeg, Manitoba.

Larnier, M. and F. Travade. 2002. The Design of Fishways for Shad. In: Larnier, M., F. Travade, and J.P. Porcher (eds). Fishways: Biological Basis, Design Criteria and Monitoring. Bull. Fr. Piscic. 364 suppl. 208 p.

Legendre, L. and W.D. Watt. 1970. The Distribution of Primary Production Relative to a Cyclonic Gyre in Baie des Chaleurs. Marine Biology, 7(2): 167-170.

Leopold, L. B., Wolman, M. G., and Miller, J. P., 1964. Fluvial processes in geomorphology. Freeman and Company, San Francisco, CA. 522 p.

Liem, A.H. and W.B. Scott. 1966. Fishes of the Atlantic Coast of Canada. Bull. No. 155. Fish. Res. Bd. Canada.

MacPhail, J.S. 1964. 1963 Survey of Eel River Cove, N.B., Soft-Shell Clam (*Mya arenaria*) Population. Prepared for Biological Station, St. Andrews, New Brunswick

Martijn, C. 1968. An Archaeological Survey of the Northeast Coast of New Brunswick (Restigouche and Glouster Counties).

McCarthy, L.W. 1963. Maritimes Marshland Re-development Association. Note in letter to J.C. Smith, Plant Engineer, N.B. International Paper Co.

Medcof, J.C. 1967. Third Survey of Eel River Cove, N.B., Soft-Shell clam (*Mya arenaria*) population. Biological Station, St. Andrews, New Brunswick. November 1967. Fish. Res. Bd. Canada M.S. Rep. No. 941. 42 p., 10 tables, 4 figures.

Natural Resources Canada. 1999. Canada's Emissions Outlook: An Update. Internet Publication: http://www.nrcan.gc.ca

Natureserve Version 4.2 (January 11, 2005). http://www.natureserve.org/

NB Power. 2005. Minutes of meeting with NB Power. NB Power Boardroom, Dalhousie Generating Station, Dalhousie, New Brunswick. November 09, 2005.

NBDELG (New Brunswick Department of the Environment and Local Government). 2004a. A Report on Air Quality Monitoring Results in New Brunswick for the Year 2002. Sciences and Reporting Branch. Technical Report T-2003-01. Fall 2004.

NBDELG (New Brunswick Department of the Environment and Local Government). 2004b. A Report on Air Quality Monitoring Results in New Brunswick for the Year 2003. Sciences and Reporting Branch. Winter 2004.

NBDELG (New Brunswick Department of the Environment and Local Government). 2003. A Report on Air Quality Monitoring Results in New Brunswick for the Year 2001. Sciences and Reporting Branch. Technical Report T-2002-02. Spring 2003.

NBDELG (New Brunswick Department of the Environment and Local Government). 2002. A Report on Air Quality Monitoring Results in New Brunswick for the Year 2000. Sciences and Reporting Branch. Technical Report T-2001-01. Spring 2002.

NBDELG (New Brunswick Department of the Environment and Local Government). 2000. A Report on Air Quality Monitoring Results in New Brunswick for the Year 1999. Sciences and Reporting Branch, Technical Report T-2000-08, December 2000.

NBDELG (New Brunswick Department of the Environment and Local Government). 1984. Summary of Operating Conditions of Wastewater Treatment Plants, Province of New Brunswick.

NBDNR (New Brunswick Department of Natural Resources and Energy). 2005. New Brunswick Regulation 96-26 under the Endangered Species Act. Online: http://www.gnb.ca/0062/regs/96-26.htm

NBDNR (New Brunswick Department of Natural Resources and Energy). 2003a. General Status of Wildlife in New Brunswick: Draft vascular plant status.

NBDNR (New Brunswick Department of Resources and Energy). 2003b. National Geochemical Reconnaissance, GSC Open File 1831/NBDNR Open.

NBDNR (New Brunswick Department of Resources and Energy). 1998. Ni, Cr, and V Content of Stream-Sediment Samples for Part of the Charlo Map Area (NTS 21 O/16), Restigouche County, New Brunswick.

NBDNR (the New Brunswick Department of Natural Resources and Energy). 1993. Electrofishing Research Project Eel River Basin and Murray Brook. Prepared for the Eel River Band Council and the Eel River Crossing Village Council.

NBDNR (the New Brunswick Department of Natural Resources and Energy). 1992. Trout & Salmon Population Survey on Eel River, Restigouche County, NB – 1992. Prepared for the Eel River Band Council and the Eel River Crossing Village Council.

NBDNR (New Brunswick Department of Natural Resources). 1979. Geological Map of New Brunswick, Second Edition.

NBDOE (New Brunswick Department of the Environment). 1999. A Report on Air Quality Monitoring Results in New Brunswick for the Year 1998. Environmental Evaluation Section, Technical Report T-9904, December 1999.

NBDOE (New Brunswick Department of the Environment). 1979. Campbellton-Dalhousie Planning Region Water Resources Review, Water Resources Branch, New Brunswick Department of the Environment. Report I-7902. July 1979.

NBDSS (New Brunswick Department of Supply and Services. 2003. Removal of the Eel River Dam – Registration Document for Environmental Impact Assessment. Fredericton, New Brunswick.

NBWA (New Brunswick Water Authority). 1962. Letter from John S. Bates to J.F.J. Thomas (Department of Mines and Technical Surveys). Re: Eel River Water Analyses (June 27, 1962).

Neill, C. R. (Ed). 1973. Guide to bridge hydraulics. Roads and Transportation Association of Canada. University of Toronto Press, Toronto, ON. 191 p.

Neill and Gunter Limited and Gemtec Limited (NGL and Gemtec Limited). 1999. Alternative Water Supply Study: Dalhousie Area. Prepared for the Town of Dalhousie and the Department of the Environment. 15 pp.

Neill and Gunter Limited and Porter Dillon Limited (NGL and PDL). 1986. Water Supply Evaluation for New Brunswick International Paper Company and Town of Dalhousie. Fredericton, New Brunswick.

Quinn, R.F. 1994. Fish passage facilities for Alosa. In: Cooper, J.E., R.T. Eades, R.J. Klauda and J.G. Loesch. Anadromous Alosa Symposium. Proceedings of a symposium held at the 7th annual meeting of the Tidewater chapter of the American Fisheries Society, Jan. 14, 15, 1993. 169 p.

Rampton, V.N., R.C. Gauthier, J. Thibault, and A. A. Seaman, 1984. Quartenrary Geology of New Brunswick. Geological Survey of Canada. Memoir 416.

Richard, B. and P. Godin. 2003. Re-evaluation Report: New Brunswick Shellfish Growing Area Sectors 1-010-001 to 3-050-002, Restigouche River to Grande Rivière Tracadie. Environment Canada Manuscript Report No. EP-AR-2003-1, April 2003.

Ross, K. 1993. Eel River Project 1993 – Trout and Salmon Counting Station and Head Pond (sic.) survey. Prepared for the Eel River Band Council and the Eel River Crossing Village Council.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Ottawa.

Shaw, J., R.B. Taylor, D.L. Forbes, M.-H. Ruz, and S. Solomon. 1998. Sensitivity of the Coasts of Canada to Sea-level Rise. Geological Survey of Canada. Bulletin 505. Ottawa, Ontario. Cited in: The Atlas of Canada. 2005. Accessed online on August 9, 2005 at http://atlas.gc.ca/site/english/maps/climatechange/potentialimpacts/coastalsensitivitysealevelrise.

Stormy Weather Software. Undated. Tides Version 2.32.

TAP (TAP Environmental Resources Inc.). 2003. Groundwater Resources – Chaleur Area (Balmoral, Charlo, Dalhousie, Eel River Crossing). Engineering Considerations by Boissonnault McGraw and Associates Ltd.

Thibault, P. 2005. Eel River Bar First Nation: Aboriginal Heritage Gardens - Interpretive Plan Exhibition Manual, September 2005.

UNB Herbarium (Connell Memorial Herbarium, Department of Biology, University of New Brunswick), Fredericton, New Brunswick, Canada. Dr. Gary Saunders, Curator.

US Water News. 1997. Federal officials order removal of Maine's Edwards Dam. http://uswaternews.com/archives/arcsupply/7fedoff12.html .

WGA (Washburn & Gillis Associates Ltd.). 1989. Belledune 450 MW Thermal Generating Station Environmental Impact Assessment Report. Submitted to the New Brunswick Electric Power Commission, 28 July 1989.

Wentzel, R.G. 1975. Limnology. W.B. Saunders Company. 1975.

Appendix A

Appendix A

EIA Guidelines

Jacques
Whitford

FINAL GUIDELINES FOR AN ENVIRONMENTAL IMPACT ASSESSMENT FOR THE REMOVAL OF THE EEL RIVER DAM

Issued by the Minister of the Environment and Local Government
for the Province of New Brunswick

to

The NB Department of Supply & Services (NBDSS)

February 27, 2004

TABLE OF CONTENTS

1.0 INTRODUCTION 2
- 1.1 Background 2
- 1.2 Purpose 2
- 1.3 Environmental Impact Assessment (EIA) Process 2

2.0 METHODOLOGICAL APPROACH TO EIA 5
- 2.1 General 5
- 2.2 Study Boundaries 5
- 2.3 Prediction of Environmental Effects 6
- 2.4 Cumulative Environmental Effects 7
- 2.5 Mitigation, Contingency and Compensation 7
- 2.6 Commitment to Monitoring and Follow-Up 8
- 2.7 Public, Aboriginal and Other Stakeholder Consultation 8
- 2.8 Terms of Reference (TOR) 9

3.0 CONDUCT OF THE STUDY AND CONTENT OF REPORT 10
- 3.1 Project Purpose, Scope and Detailed Description 10
- 3.2 Identification and Analysis of Alternatives 11
- 3.3 Description of the Existing Environment (Biophysical & Socio-economic) 11
- 3.4 Cross-Referenced Index 13

4.0 POTENTIAL IMPACTS 14
- 4.1 Impacts (Effects) on the Marine Environment 14
- 4.2 Effects on the Estuarine Environment 14
- 4.3 Effects on the Freshwater Environment 15
- 4.4 Effects on Species at Risk (Flora & Fauna) 15
- 4.5 Effects on Terrestrial and Wetland Environments 16
- 4.6 Effects on Migratory Birds 16
- 4.7 Effects on Air Quality and Climate 16
- 4.8 Effects on Groundwater Resources 16
- 4.9 Effects on Vessel Traffic/Navigation 16
- 4.10 Effects on Traffic Patterns/Road Infrastructure 16
- 4.11 Effects on Infrastructure 17
- 4.12 Effects on Aboriginal Land and Resource Use 17
- 4.13 Effects on Surface Water Supply 17
- 4.14 Other Social & Economic Effects 17
- 4.15 Effects of the Existing Environment on the Project 18

Appendix A 19

1.0 INTRODUCTION

1.1 Background

The Eel River dam is located in Restigouche County south of the Town of Dalhousie, approximately 600 m upstream of New Brunswick (NB) Highway 134 at Eel River Bar. The dam extends from the Eel River Bar First Nation on the north side of the river, to the Blue Heron Campground/Park on the South. The dam was built in 1963 by the Town of Dalhousie to provide an industrial water source (non potable) for the area. Over time, the dam has resulted in a variety of changes in the hydrology of the Eel River watershed, including modifications to physical processes such as sediment transport, and a variety changes to ecosystem functions such as fish habitat and fish passage.

Removal of the dam is now being proposed by the New Brunswick Department of Supply and Services (NBDSS), with the objective of achieving a long term solution to fish passage and other ecosystem issues related to the presence of the dam (e.g., tidal exchange, sediment transport, wetland functions, populations of flora and fauna, fish habitat, etc).

An Agreement (dated December 10, 2002) was signed with the Province of NB (as represented by the NB Department of Supply & Services), Her Majesty the Queen in Right of Canada (as represented by the Minister of Indian & Northern Affairs Canada), and the Council of the Eel River Band, requiring that a full environmental assessment be conducted for the proposed decommissioning project.

The proposed project consists of the decommissioning or removal of the Eel River Dam, including the earthen dyke, concrete water control structure, and ancillary infrastructure (e.g., fish passage facilities).

1.2 Purpose

These Guidelines are to be used by NBDSS as a framework for conducting an Environmental Impact Assessment (EIA) of the proposed decommissioning or removal of the Eel River Dam.

The EIA study will examine the potential environmental effects (both positive and negative) of removal of the dam and of the status quo or null alternative (leaving the dam in place), and will identify appropriate mitigative/optimization measures. Additional options identified during the environmental assessment process may be considered as applicable.

The assessment must clearly describe the impacts (both positive and negative) of removal of the dam and compare them to the impacts (both positive and negative) of the status quo (ongoing and future impacts).

1.3 Environmental Impact Assessment (EIA) Process

Under The *Environmental Impact Assessment Regulation* (Regulation 87-83) of the NB Clean Environment Act, NBDSS, as the proponent of the project, was required to register the removal of the Eel River Dam as an undertaking for EIA review. The proposal was registered on March 28, 2003. On October 31, 2003, the Minister of the NB Department of the Environment & Local Government (the Minister) determined that the completion of a full EIA was required to assess the nature and significance of the proposal's potential impacts.

The Minister has appointed a Review Committee comprised of technical specialists from various government agencies whose jurisdictions may be affected by the undertaking. The agencies include:

- NB Department of the Environment and Local Government (NBDELG);
- NB Department of Natural Resources (NBDNR);
- NB Department of Health and Wellness (NBDHW);
- NB Department of Transportation (NBDOT);
- NB Culture & Sport Secretariat - Archaeological Services Unit (NBC&SS);
- Restigouche District Planning Commission;
- NB Museum;
- Department of Indian and Northern Affairs (DIANA);
- Canadian Coast Guard;
- Environment Canada (EC); and
- Fisheries and Oceans Canada (DFO).

The Technical Review Committee (TRC) has evaluated the initial EIA registration document provided by NBDSS and has requested additional information from NBDSS in an effort to evaluate the environmental issues for the proposed project. This screening exercise provided the basis for the Draft EIA Guidelines, which the TRC had also examined. The Guidelines outline the approach the proponent must follow in conducting the EIA. The Guidelines identify important issues, which must be considered in assessing the impacts of the proposal.

Members of the public and other stakeholders were invited to comment on the Draft Guidelines and to identify any issues of concern that did not appear in the document. Following public input, and a detailed review by the TRC, the Minister issued the Final Guidelines for the EIA.

Upon receipt of the Final EIA Guidelines, NBDSS and/or its consultant must provide the Minister with detailed Terms of Reference (TOR), which describe the approach to be used in the EIA. The TOR are evaluated through a consultative process involving the proponent and the appropriate government review agencies (TRC).

The principle objective of the EIA is to predict the impacts that can be expected should the project proceed. The EIA study, conducted in consultation with the residents from the area of potential impact, is also expected to identify methods of optimizing positive impacts and minimizing negative impacts resulting from the project.

Information gathered during the study is compiled in a Draft EIA Report. The draft report is evaluated by the TRC to determine whether the study adequately addressed the issues raised in the

Final EIA Guidelines. Should the TRC determine that the report does not adequately address the Guidelines, the proponent will be required to make revisions to address any identified deficiencies in order to advance the EIA process.

If, on the advice of the TRC, the Minister is satisfied that the Final EIA Report is adequate, the next step is additional consultation, to involve the public and other stakeholders in evaluating the potential impacts anticipated from this project.

A summary of the Final EIA Report is prepared on behalf of the Minister, to assist members of the public in becoming familiar with the information. The TRC also prepares a General Review Statement summarizing its comments on the Final EIA Report. These documents are released for a period of at least 30 days for public review and comment, after which, the schedule and location(s) of public meeting(s) are announced by the Minister.

Public meetings generally take place near the area where the project is being proposed and provide all interested parties with an opportunity to make comments, raise concerns, or ask questions about any matter covered in the EIA study. Following the public meeting, a period of fifteen days is set aside for members of the public to submit written comments to the Minister. At the end of this period, a summary of public participation is made available to the public and presented to the Minister. At any time after this date, the Cabinet (Lieutenant-Governor in Council) may render a decision to issue or deny an approval for the project.

Specific procedures to be followed in conducting an EIA may be found in Regulation 87-83, *Environmental Impact Assessment Regulation* - Clean Environment Act. A procedural summary is available in the publication entitled "Environmental Impact Assessment in New Brunswick." These documents may be obtained from the NB Department of the Environment & Local Government at the address provided below:

Mr. David Maguire
Project Assessment Branch
NB Department of the Environment and Local Government
P.O. Box 6000
Fredericton, NB
E3B 5H1
e-mail: EIA-EIE@gnb.ca
fax: (506) 453-2627

2.0 METHODOLOGICAL APPROACH TO EIA

2.1 General

The EIA process results in a detailed study of potential environmental impacts and identification of procedures that may be used to mitigate these effects. The EIA study must also identify methods of optimizing positive impacts and minimizing negative impacts resulting from the proposed project. and of the status quo or null alternative (leaving the dam in place). Additional options identified during the environmental assessment process may be considered as appropriate.

To provide a focus for the EIA. environmental components of principal concern. commonly referred to as Valued Environmental Components (VECs). must be identified early in the assessment process. The method for determining VECs must be clearly stated by the proponent. The proponent shall seek public. Aboriginal. and other stakeholder knowledge during the identification of appropriate VECs. The EIA must clearly indicate the provisions for compliance with relevant regulatory requirements. guidelines and best management practices. The assessment will include consideration of. but is not limited to. the regulations. guidelines and associated documents listed in Appendix A.

Presented in Section 4.0 of these Guidelines are a number of specific issues for study. including a variety of questions/concerns raised by the TRC during review of the initial EIA registration document. However. this framework does not limit the proposed EIA study. Should additional issues arise from discussion with members of the TRC. or consultation with regulatory agencies. Aboriginal communities. members of the public. or other stakeholders. the proponent must incorporate these issues into the assessment of the project's potential impacts.

2.2 Study Boundaries

The proponent (NBDSS) must clearly describe the boundaries of the study in time and space used in the evaluation of environmental effects for each VEC. The temporal boundaries of the study (the length of time over which project environmental effects are anticipated to occur) must reflect the decommissioning period. and extent of any potentially significant environmental effects that may remain beyond the decommissioning period. including any potential accidents or malfunctions.

Spatial boundaries must reflect the geographical extent to which activities associated with the proposed project are anticipated to occur in the existing environment and the extent of existing or anticipated environmental effects. including cumulative environmental effects for each VEC (i.e.. both positive and negative). Boundaries such as administrative. technical. biophysical. socio-economic and the areas over which activities may occur. must be defined and related to the impact assessment process as appropriate. In determining applicable spatial boundaries. consideration must be given to environmental effects potentially resulting from the proposed project on a local. regional and national scale. as applicable.

A similar assessment must also be applied to the null alternative or status quo (leaving the dam in place), to allow a detailed assessment of negative impacts that could result from not proceeding to remove the dam structure.

2.3 Prediction of Environmental Effects

The main focus of the EIA is to predict environmental effects (i.e., both positive and negative) that may result from the proposed project or from the null alternative or status quo, and their potential significance. Predictions must consider all aspects and phases of the proposed project/ status quo, and any indirect environmental effects, cumulative effects, and any effects that may result from accidents or malfunctions. In addition, potential effects of the environment on the proposed project/status quo must be predicted, such as effects that may be caused by extreme weather events (e.g., flood/ice damage; tidal surges), seismic activity, acid rock drainage and climate change.

EIA predictions are generally based on a combination of objective and subjective evaluation. The use of objective (measurable) analysis is strongly preferred where it is technically feasible and reasonable to do so. However, in recognition of any factor that may limit the ability to predict or measure environmental responses, predictions may be based on subjective evaluation using professional judgement and experience. Community knowledge and Aboriginal traditional knowledge may also be utilized, as applicable. In consideration of this, predictive statements must be accompanied by a discussion of the limitations of the analysis, references to supporting documentation and the qualifying credentials of those making the predictions.

Predictions must be made regarding the nature (adverse or positive), magnitude, duration, frequency, geographic extent and reversibility of the proposed project/status quo's potential or existing environmental effects. The significance of these effects must also be determined. These predictions must:

- facilitate decision-making with respect to the proposed project;
- clearly specify any degree of uncertainty inherent in the projections;
- clearly identify positive and negative environmental effects (both biophysical and socio-economic) of the proposed project/status quo; and
- be amenable to testing where possible through ongoing monitoring initiatives.

To clearly distinguish potentially significant environmental effects from those likely to be insignificant, the proponent must first define "significant." The definition must be based on scientific determinations, social values, public concerns, and economic judgements. In particular, the significance of proposed project-induced changes on VECs must be clearly stated in the EIA Report (Environmental Impact Statement, EIS). The thresholds for significant effects on VECs (i.e., both positive and negative) must be related in terms of applicable criteria. Quantifiable reference to the magnitude, geographical extent, duration, frequency, reversibility and ecological context of the potential environmental effects is required. Significance must be determined in the context of project-specific and cumulative environmental effects and after taking into account the implementation of appropriate mitigation/optimization measures.

Significant effects on species (i.e., tolerance levels related to organisms in the environment), must take into account effects at the population-level. For species designated as endangered, effects on an individual constitute a population-level effect.

2.4 Cumulative Environmental Effects

The term cumulative environmental effects refers to those effects, over a defined period of time and distance, resulting or likely to result from the proposed project, in combination with other past, present, or likely (imminent) future projects or activities. An assessment of cumulative environmental effects must be conducted as part of the EIA study, in consideration of identified VECs.

The goal of the cumulative effects assessment will be to place project-related and status quo induced impacts, their significance, and approaches to their management in the context of the "bigger picture," and must include (but is not limited to):

- identification of regional issues of concern;
- a comprehensive description of how VECs were selected;
- a clear justification for the spatial and temporal boundaries used to address cumulative effects;
- a clear description of the analysis undertaken to assess the cumulative effects on the selected VECs (i.e., both positive and negative), and presentation of the results;
- a clear description of how mitigation measures address the cumulative environmental impacts; and
- the rationale for determining whether residual cumulative effects on VECs are significant.

2.5 Mitigation, Contingency and Compensation

The EIA study must describe general and specific measures that are technically and economically feasible for the proponent (NBDSS) to implement, to optimize any positive environmental effects and mitigate any negative effects resulting or potentially resulting from the proposed project/status quo (i.e., maximize positive effects, and eliminate, prevent, avoid or minimize adverse effects). This must include a description of contingency measures (including emergency response plans) that have been designed to address potential accidents and malfunctions that could result in spills or unplanned releases of contaminants or products to the environment. Specific circumstances under which mitigative measures will be implemented must be clearly defined by the proponent. Mitigation options must be considered in a hierarchical manner with a clear priority placed on proactive measures for impact avoidance and pollution prevention opportunities. Opportunities to contribute to a regional approach to management of cumulative effects must also be identified (refer to Section 2.4 above).

An outline for contingency plans must also be provided:

- for use in the event of an environmental emergency attributable to the project, within the spatial boundaries of the study; and
- for use in the event of significant impacts, attributable to the project, which are detected through monitoring (this plan must be designed to be implemented should impacts be detected through monitoring).

The study must also consider compensation mechanisms to be used in the event that any unforeseen, accidental, or residual environmental effects occur (including opportunity costs). These compensation mechanisms/plans must be developed through consultation with federal and provincial agencies and other stakeholders, as appropriate. Compensation must be recognized as a last resort, but may be required if deliberate project-related effects cannot be otherwise mitigated.

2.6 Commitment to Monitoring and Follow-Up

A well-defined program of monitoring and follow-up initiatives regarding environmental effects resulting or potentially resulting from the proposed project must be outlined in the EIA Report. NBDSS must describe all of their proposed monitoring and follow-up programs, including their objectives, content, and implementation and reporting schedules. Monitoring programs will be required to:

- establish baseline conditions;
- determine regulatory compliance (compliance monitoring);
- test the predictions of the EIA (environmental effects monitoring, EEM); and
- evaluate the effectiveness of measures used to mitigate environmental effects (EEM).

Monitoring programs should include protocols that would guide interpretation of monitoring results and timely implementation of appropriate corrective actions.

Monitoring initiatives must be based upon accurate baseline information for the existing physical, biological and socio-economic environments. The proponent is expected to collect the necessary information through existing data sources ("data mining") or through primary research such as fieldwork and laboratory testing, as required.

Where the EIA predictions are not based on objective information, monitoring programs must be designed, where possible, to collect relevant data not previously available.

Monitoring and follow-up programs must include protocols to guide interpretation of monitoring results and timely implementation of appropriate corrective actions.

2.7 Public, Aboriginal and Other Stakeholder Consultation

NBDSS must continue to consult with persons and organizations potentially affected by the proposed project (or already affected by the presence of the dam), and must continue to inform and engage individuals, Aboriginal groups/communities, interest groups, and other stakeholders in this assessment. This will include local governments and specific groups with mandates/initiatives encompassing the Eel River watershed (e.g., communities such as Balmoral, Charlo, Dalhousie, Eel River Crossing, the Eel River Bar First Nation, Local Service Districts, NB Power, Bowater, etc). NBDSS will be expected to hold appropriate public and other consultation events (e.g., study updates, open-houses, etc), with the following consultation objectives:

- to ensure that the potentially affected public and other stakeholders are engaged in meaningful discussion and are well informed prior to the government's decision, as to the nature and extent of environmental effects attributable to the proposed project and status quo (i.e., both positive and negative effects);
- to ensure that the values and concerns of the public and other stakeholders are incorporated and adequately addressed in the study; and
- to obtain expertise (where applicable), including community knowledge and Aboriginal traditional knowledge from various stakeholders and Aboriginal communities and organizations.

The EIA must document the dates and formats for public and other stakeholder consultation undertaken, the material presented, the opportunity for receiving input, a summary review of any concerns expressed, and how these concerns were addressed. It must be clear how the input from consultations was used in the assessment and what changes to the process or project were made as a result of comments provided.

2.8 Terms of Reference (TOR)

The proponent must submit detailed TOR in response to the Final EIA Guidelines. The TOR must clearly describe the methods proposed for carrying out the EIA, and the means by which NBDSS will consult with the public, Aboriginal communities, and other stakeholders during the course of the EIA process.

The Proponent is required to provide, as part of the TOR, a cross-referenced index (Concordance or Disposition Table) showing where the content and issues of the Final EIA Guidelines have been addressed. The TRC will examine the TOR and comments/deficiencies may be provided to the proponent to address prior to finalization.

In addition, the TOR must outline the components of any proposed field programs, any anticipated challenges/obstacles to be encountered, proposed modelling approaches (if applicable), identify key members of the study team, and fully describe all specific tasks to be completed as part of the study.

3.0 CONDUCT OF THE STUDY AND CONTENT OF REPORT

The EIA Report (Environmental Impact Statement - EIS) must be written in the clearest language possible. Where the complexity of the issues addressed requires the use of technical language, a glossary defining technical words and acronyms must be included. The International System of Units (SI) must be used throughout the report and all supporting documents. The study must include consideration of, but is not limited to, the regulations, guidelines and associated documents listed in Appendix A.

The following titles may be used as a framework for the development of the EIA Report:

- Executive Summary
- Introduction
- Regulatory Framework (e.g., Application of Regulation 87-83/CEAA)
- Scope of the Project
- Scope of the Environmental Assessment
- Purpose and Description of the Project
- Identification & Analysis of Alternatives
- Description of the Existing Environment
- Environmental Effects (including effects of malfunctions and accidents & cumulative effects) and Mitigation Measures
- Significance of Residual Effects
- Public, Aboriginal, and Other Stakeholder Consultation
- Monitoring Initiatives and Follow-Up Programs
- Conclusion/Recommendation

3.1 Project Purpose, Scope and Detailed Description

The report must clearly outline the project purpose (i.e., provide clear justification for the project), in order to allow for a thorough evaluation of the potential environmental effects of the proposal (i.e., both positive and negative).

The EIA Report must provide a complete and accurate description of the project from planning through decommissioning of the dam (including any post-decommissioning activities), supported with appropriate maps and diagrams. Emphasis will be placed on describing those aspects of the project (including accidents and malfunctions) that have a reasonable probability of occurrence that could be expected to affect the environment. This description must include, but is not limited to:

- the history of the Eel River Dam, and applicable general information on the construction and operation of tidal barriers;
- overview of the environmental impacts that have occurred over time due to the construction & presence of the dam;

- proposed methods for removal of the dam and associated infrastructure (e.g., fishway, etc.);
- proposed modifications/additions to existing infrastructure;
- transportation/handling and storage systems of hazardous materials required for decommissioning;
- transportation, handling and storage systems of wastes/by-products from decommissioning;
- the decommissioning methodology;
- a detailed description of the decommissioning phase proposed, focussing on options/strategies that have been proven elsewhere;
- appropriate regulatory standards/specifications which the project will meet;
- proposed secondary containment systems (if applicable);
- the layout and detailed description of associated infrastructure (e.g., access/road infrastructure);
- upsets of environmental control equipment which may change the nature of site runoff, emissions and/or effluent; and
- a detailed description of all health & safety, and environmental protection measures, including contingency plans (e.g., emergency response plans - fire prevention/control equipment, spill response, flooding and tidal surge protection measures, etc.).

As applicable, the project description will include all the elements necessary to support the assessment of existing (for the status quo or null or do nothing alternative) and potential environmental effects of removal of the dam, as outlined in Section 4.0 of these Guidelines.

3.2 Identification and Analysis of Alternatives

Using the approach indicated below, the study must evaluate alternatives to the project as proposed (i.e., leaving the dam in place), and alternative means of carrying out the project (i.e., different methods for removing/decommissioning the dam). This analysis will contribute to a further understanding of the project rationale and to alternative methods of implementing the project, and will facilitate decision-making related to the proposal.

The analysis must include a comparison of alternatives to the project and alternative means of carrying out the project and an assessment of the potential environmental effects, as follows:

(a) The null or "do nothing" alternative (not removing the dam and ancillary infrastructure). The study must examine the implications of not proceeding with the project with reference to environmental (both biophysical and socio-economic) factors/effects.

(b) The analysis must include consideration of alternative means of carrying out the proposed project/decommissioning that are technically and economically feasible, and the environmental effects of any such alternative means.

3.3 Description of the Existing Environment (Biophysical & Socio-economic)

Section 31.1(1) of the Clean Environment Act, defines "environment" as:

(a) air, water, or soil

(b) plant and animal life including human life, and

(c) the social, economic, cultural and aesthetic conditions that influence the life of humans or a community as they are related to the matters described in (a) and (b).

The EIA Report must describe the existing environment focusing on identified VECs (Valued Environmental Components) within the study boundaries. This description must reflect the dynamics of environmental components (biophysical, social, and economic), and identify trends in the context of predicted changes over time.

A description of the existing environment in the study area must consider, but is not limited to, the following:

- Atmospheric environmental components, including climatic and ambient air quality data;
- Terrestrial physical environmental components, including topography, geology, watershed hydrology, groundwater resources, and seismic activity;
- Terrestrial biological environmental components, including species at risk and their habitats (flora and fauna), species migratory patterns, ecologically sensitive or significant areas, and protected areas/critical habitat features. Migratory bird descriptions must include when each species is likely to be present in the study area and areas typically used for nesting, foraging, and/or staging;
- Wetlands;
- Aquatic physical environmental components (freshwater, estuarine, and marine), including bathymetric/geomorphologic, hydrodynamic, water quality, sediment and ice regime, and coastal and oceanographic data;
- Aquatic biological environmental components (freshwater, estuarine, and marine), including fish, fish habitat, fishery resources, species at risk and their habitats, species migratory patterns, ecologically sensitive or significant areas, and protected areas/critical habitat features (e.g., Environmentally Significant Area #006: Eel River Cove);
- Socio-economic environmental components, including demographic data (e.g., population and labour force), local economy, past, current and foreseeable land use (e.g., current surface water supply/use), recreational activities/infrastructure, zoning restrictions, regional fishing operations, the seasonal variations of fishing activities, physical and cultural heritage, any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, transportation and associated infrastructure, existing public health and safety concerns, and ambient noise levels (near potentially affected habitation). With specific reference to fisheries, the description must include a socio-economic profile of each identified fishery);
- Current use of land and resources for traditional purposes by Aboriginal persons; and
- Current emission and effluent volumes and characteristics, including any points of discharge from storm water and sewer treatment and collection systems (both routine and upset/ emergency scenarios).

In developing the description of the existing environmental setting, field investigations may be required to address information deficiencies and facilitate the assessment.

In addition, due to the unique nature of this EIA study (i.e., the assessment of the potential effects of a restoration or "undevelopment" project), a similar description of pre-dam conditions (i.e., pre-1963) must be included to support the assessment.

3.4 Cross-Referenced Index

To assist the readers, a cross-referenced index (i.e., Concordance or Disposition Table), which shows where the content and issues outlined in the Final EIA Guidelines are addressed in the report, is required. This index must be submitted with the Draft EIA Report/EIS.

4.0 POTENTIAL IMPACTS

Presented here are a number of specific issues for study. However, this framework does not limit the assessment. Should additional relevant issues, concerns, or potentially significant environmental effects be identified through discussion with members of the TRC, regulatory agencies, the public, Aboriginal groups/communities, or other stakeholders, NBDSS must incorporate these issues into the assessment. The assessment must include consideration of, but is not limited to, the regulations, guidelines and associated documents listed in Appendix A

The capacity of renewable resources that are likely to be significantly affected by the project (either positively or negatively) to meet the needs of the present and those of the future should also be considered. Cumulative environmental effects should be considered individually for each identified VEC.

All existing and potential environmental effects (i.e., both positive and negative) resulting from the continued presence of the dam, and potential project-related environmental effects from the proposed decommissioning of the dam (including potential effects resulting from accidents or malfunctions), must be included in the assessment. A comparison of net positive and negative impacts must also be included.

4.1 Impacts (Effects) on the Marine Environment

VECs to be considered in the marine environment will include (but are not to be limited to) fish and fish habitat, and fisheries resources in areas potentially affected by the project.

The impact of the proposed project on marine water quality and the benthic environment will be assessed. Predict the environmental effect of any potential deterioration and/or improvement in water quality on marine environment VECs.

Evaluate the impact (both positive and negative) to VECs in the marine environment from the release of any deleterious substances (including sediment) resulting from project activities. The implications of potential water quality improvements must also be considered.

Describe the procedures for the development and the anticipated components of an environmental protection/emergency response plan, including spill prevention, and spill response contingency planning.

4.2 Effects on the Estuarine Environment

Assess the environmental effects of the proposed project on the estuarine environment, including (but not limited to) characteristics of the tidal regime, channel dimensions and shape, ice and sediment movement, water quality, fish and fish habitat within the environmental assessment boundaries.

The impact of project activities on estuarine water quality and the benthic environment will be assessed. Predict the environmental effect of any potential deterioration/improvement in water quality on estuarine environment VECs.

4.3 Effects on the Freshwater Environment

Assess the environmental effects of the proposed project on the freshwater environment (including impoundment), including (but not limited to) water quality, fish and fish habitat within the environmental assessment boundaries.

The impact of project activities on freshwater quality and the benthic environment will be assessed. Predict the environmental effect of any potential deterioration/improvement in water quality on freshwater environment VECs

4.4 Effects on Species at Risk (Flora & Fauna)

Assess the environmental effects of the proposed project on species considered to be at risk under national, provincial and regional classification systems (i.e., endangered, threatened, species of special conservation status, and rare species). Include consideration of any species at risk (flora and fauna) known to occur within the zones of influence of the proposed project and for which there are potential project-VEC interactions anticipated that could result in significant environmental effects.

The following information sources on species at risk in the general project area must be consulted:

- Atlantic Canada Conservation Data Centre (AC CDC);
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC; List - most recent update available);
- Species at Risk Act (SARA) Registry;
- New Brunswick Museum;
- NBDNR;
- Canadian Wildlife Service (CWS) of Environment Canada; and
- Local naturalist and interest groups.

In addition, the proposed project must be assessed for the potential for re-establishment of species designated as at risk, if applicable.

The assessment must also describe mitigative measures proposed to prevent or minimize impacts to species at risk.

4.5 Effects on Terrestrial and Wetland Environments

Assess the potential environmental effects of the proposed project on terrestrial and wetland environments (i.e., where there is potential for significant project/VEC interaction). Predict the potential effects on wetland VECs resulting from the proposed project.

4.6 Effects on Migratory Birds

Assess the potential environmental effects of the proposed project on migratory birds and migratory bird habitat. Include consideration of migratory birds that occur within the zones of influence of the project and for which there are potential project-VEC interactions that could result in significant environmental effects.

4.7 Effects on Air Quality and Climate

Assess the environmental effects of the proposed project on air quality. The generation of odour (e.g., from decomposition of previously submerged vegetation, etc), and the generation of wind-borne dust from the proposed project must be considered (including the need (if any) for dust monitoring).

Potential project emissions that will contribute to the atmospheric load of Greenhouse Gas (GHG) emissions must be assessed. Also, the potential loss or enhancement of carbon dioxide sinks will be discussed.

A discussion of any anticipated impacts of the proposed project on the local climate must be included.

4.8 Effects on Groundwater Resources

Assess the potential environmental effects of the proposed project on groundwater/drinking water supply resources.

4.9 Effects on Vessel Traffic/Navigation

Assess the potential environmental effects of the proposed project on vessel traffic/navigation (i.e., recreational, commercial, and other). This assessment must take into consideration existing and any predicted changes to vessel traffic.

4.10 Effects on Traffic Patterns/Road Infrastructure

Assess the environmental effects of the proposed project on traffic patterns/flows, including a prediction with respect to current/future road infrastructure and use.

4.11 Effects on Infrastructure

The effects of the proposed project on existing (and planned) wastewater treatment lagoons and other infrastructure in the vicinity of the dam, including industrial outfalls (discharges), water supply conduits, drainage works, pipelines, dyke-land infrastructure, landfills, fibre-optic and power lines, and other public infrastructures must be examined. This includes the potential for leakage/spillage or mobilization of hazardous materials.

4.12 Effects on Aboriginal Land and Resource Use

Assess the effects of the proposed project on the current use of lands and resources for traditional purposes by Aboriginal persons (e.g., traditional fisheries, the Aboriginal Heritage Garden Project, etc).

4.13 Effects on Surface Water Supply

Assess the effects of the proposed project on current users of water from the impoundment (including how loss of this currently utilized freshwater source will be replaced).

4.14 Other Social & Economic Effects

The social and economic effects potentially resulting from the proposed project must be predicted. Evaluate the environmental effects of the proposed project on land use, including resource harvesting (i.e., within the defined environmental assessment boundaries of the project), and how any change in flood risk could affect land use.

Discuss any aesthetic/potential visual impacts of the proposed project on the Eel River. This must include identification of features recognized by the local public as being aesthetically preferred, and consideration of professional input related to aesthetics and landscape architecture.

The effect of the proposed project on existing tourism and recreational activities must also be included (e.g., hunting - the site is one of the few opportunities for waterfowl hunting in Northeastern NB; recreational land use - The Village of Eel River Crossing with financial support from NBDNR has established a trail on Crown Land adjacent to the impoundment above the dam; the sand bar below the dam - which supports an active provincial road and is also highly used for recreational purposes by local residents).

The effect of the proposed project on physical and cultural heritage, and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance must also be included.

The effect of the proposed project on industries, including the fishing industry (e.g., salmon, clams, smelt, etc) must also be included.

The effect of the proposed project on land ownership must also be included (e.g., ownership of any previously submerged lands, etc).

4.15 Effects of the Existing Environment on the Project

The assessment must take into account how the existing environment could adversely affect the proposed project (e.g., acid rock drainage, severe meteorological conditions, seismic events, tidal influences, etc.).

Sensitivity of the proposed project to variations in meteorological conditions, including extreme events, must be fully investigated. Among the parameters to be considered are the effect of extreme precipitation events on site water management and the influence of wind, waves, ice, and flooding on infrastructure. In addition, the sensitivity of the proposed project to climate variability and climate change must be identified and discussed. Not only will the assessment look at the current climatic setting in the area, but must also include a consideration of the potential future climatic conditions due to climate changes in the foreseeable future.

Appendix A

Partial Reference List

Agriculture Canada. 1992. Water erosion risk. Maritime Provinces. Canada Soil Inventory. Centre for Land and Biological Resources Research. Research Branch. Agriculture Canada. Contribution Number 91-10.

AMEC. 2002. Public and Other Stakeholder Consultation on the Proposed Environmental Impact Assessment Process Related to the Petitcodiac Causeway. AMEC Earth & Environmental Limited. Fredericton. NB. May 25. 2002.

Anderson. P.G.. B.R. Taylor. and G.C. Balch. 1996. Quantifying the effects of sediment release on fish and their habitats. Can. Manuscri. Rep. Fish. Aquat. Sci. 2346: 110 p. + 3 Append.

Applicable City. Town. Village. and Local Service District Plans

Appleby. J.P. and D.J. Scarratt. 1989. Physical effects of suspended solids on marine and estuarine fish and shellfish with special reference to ocean dumping: A Literature Review. Can. Tech. Rep. Fish. Aquat. Sci. 168:v + 33 p.

Archaeology Services New Brunswick (ASNB). 1992. Heritage Resource Impact Assessment in New Brunswick - A Guide for Consultants.

Argus. G.W. and K.M. Pryer. 1990. Rare Vascular Plants in Canada. Canadian Museum Nature. Ottawa. Ontario.

Beanlands. G.E. and P.N. Duinker. 1983. An ecological framework for environmental impact assessment in Canada. Institute for Resource and Environmental Studies. Dalhousie University. Halifax. Nova Scotia.

Boissonnault. McGraw & Associates Ltd. & CG&S Ltd. 2000. Assessment of the Impact of Removing the Eel River Dam on the Development of Environmental. Economic and Social Benefit from the Eel River.

Bond. W.K.. K.W. Cox. T. Heberlein. E.W. Manning. D.R. Witty and D.A. Young. 1992. Wetland Evaluation Guide. Final report of the Wetlands are not Wastelands Project. North American Wetlands Conservation Council (Canada). Issues Paper. No. 1992-1. 121 p.

Canadian Council of Ministers of the Environment (CCME). Revised 2000. Canadian Water Quality Guidelines. Prepared by the Task Force on Water Quality Guidelines. Inland Waters Directorate. Environment Canada.

Canadian Environmental Assessment Agency. 1994. Responsible Authorities Guide. and web page: www.acee-ceaa.gc.ca/index_e.htm.

Canadian Environmental Assessment Agency. 1999. Cumulative Effects Practitioners Guide.

Canadian Environmental Assessment Act

Canadian Environmental Protection Act

Canadian Environmental Quality Guidelines (1999)

Canadian Wildlife Service Occasional Paper No. 1 "Birds Protected in Canada under the Migratory Birds Convention Act" (1991).

Clayden, S.R., D.F. McAlpine, and C. Guidry, 1984. Rare and Vulnerable Species in New Brunswick. Publications in Natural Science No. 2. The New Brunswick Museum.

COSEWIC 2002 (or most recent update available). List of Canadian Species at Risk. May 2002.

D. J. Hood & Associates Ltd. 2000. Issues Scoping Exercise – Removal of Eel River Dam. Prepared for the Department of the Environment & Local Government. August 10, 2000.

Environment Canada. 2002. Species at Risk Website. http://www.speciesatrisk.gc.ca/Species/English/SearchRequest.cfm

Environment Canada. 2000. Atlantic Canada Standards and Guidelines manual for the Collection, Treatment and Disposal of Sanitary Sewage.

Environment Canada. 1987. New Brunswick Wetlands Atlas. Wetlands Protection Mapping Program. Canadian Wildlife Service Atlantic Region.

Environment Canada. 1986. Atlantic Provinces: Active Hydrometric Stations Reference Index. Inland Waters Directorate, Atlantic Region.

Environment Canada. 1991. The Federal Policy on Wetland Conservation. Government of Canada. 14 pp., and associated Implementation Guide for Federal Land Managers

Environment Canada Wetland Environmental Assessment Guideline (1998)

Environment Canada Migratory Bird Environmental Assessment Guideline (1998)

Environmental Impacts of Barriers on Rivers Entering the Bay of Fundy: Report of an ad hoc Environment Canada Working Group (Technical Report Series No. 334, 1999).

Fisheries Act

Fisheries & Oceans Canada. 1971. Anadromous Fish Passage Problems Associated with Tidal Structures (DFO, 1971)

Fisheries & Oceans Canada. 1991. Effects of Moncton-Riverview Causeway on Anadromous Fish Stocks of the Petitcodiac River (DFO, 1991).

Fundy Issues: Whither the Waters? Tidal and Riverine Restrictions in the Bay of Fundy (Issue # 11. Spring. 1999).

Ganong. W.F. 1899. A monograph of Historic Sites in the Province of New Brunswick. Reprinted by Print N' Press Ltd., 1983.

Health Canada 1996. Canadian Water Quality Guidelines. Canadian Council of Resource and Environment Ministers. April 1996.

Hinds. H.R. 2000. Flora of New Brunswick. Second Edition. Biology Department. University of New Brunswick.

Indian Claims Commission. 1997. Eel River Bar First Nation Inquiry – Report on: Eel River Dam Claim. December 1997.

Jain. R.K. et. al., 1993. Environmental Assessment. McGraw-Hill. Inc. 526 pp.

Migratory Birds Convention Act (and associated Regulations)

Nature Trust of New Brunswick Inc. (NTNBI). 1995. Environmentally Significant Areas in New Brunswick: A Preliminary Listing. Prepared under contract for the New Brunswick Environmental Trust Fund. Contact Mr. Kevin Pugh. DELG. (506) 457-4846.

Navigable Waters Protection Act

Neill and Gunter Ltd., & Gemtec Ltd. 1999. Alternate Water Supply Study – Dalhousie Area. Project #9308. February 24. 1999.

New Brunswick Clean Environment Act

New Brunswick Coastal Areas Protection Policy

New Brunswick Department of the Environment. 1997. Watercourse Alterations Technical Guidelines. Prepared by the NB Watercourse Alteration Technical Committee.

New Brunswick Department of Natural Resources and Energy. 2000. Bedrock Geology of New Brunswick. Minerals and Energy Division.

New Brunswick Department of Natural Resources. 2003. The General Status of Wildlife in New Brunswick: Draft Vascular Plant Status. Fish & Wildlife Branch.

New Brunswick Department of Natural Resources. 2004. The General Status of Wildlife in New Brunswick. Fish & Wildlife Branch.

New Brunswick Water Supply Source Assessment Process

New Brunswick Watercourse and Wetland Alteration Permitting Process

New Brunswick Water Classification Regulation

New Brunswick Wellfield Protected Area Designation Order

New Brunswick Wetlands Conservation Policy

Niles, E. 2002. Public and Other Stakeholder Consultation. Draft Guidelines For the Environmental Impact Assessment (EIA) Study Of the Petitcodiac River Causeway: Final Report. E.J. Niles & Associates. Cap-Pelé. New Brunswick. July 19. 2002.

Sherk. J.A.. J.M. O'Conner. D.A. Neumann. R.D. Prince and K.V. Wood. 1974. Effects of suspended and deposited sediments on estuarine organisms. Phase II. Univ. Maryland. Nat. Resources Inst.. Ref. No. 74-20.

TAP Environmental Resources Inc. 2003. Groundwater Resources – Chaleur Area (Balmoral. Charlo. Dalhousie. Eel River Crossing). April 10. 2003.

Appendix B

Appendix B

Supplementary Hydrodynamic and Geomorphological Investigation Information

Jacques
Whitford

Jacques
Whitford

NBDSS PROJECT NO. YR101A

JW PROJECT NO. NBF15830

REPORT TO	**New Brunswick Department of Supply and Services** **414 Collishaw Street** **Moncton, New Brunswick** **E1C 3C7**
FOR/ON	**Supplementary Hydrodynamic and Geomorphological Investigation Information**

March 31, 2006

Jacques Whitford
711 Woodstock Road
PO Box 1116
Fredericton, New Brunswick
E3B 5C2

Phone: 506-457-3200
Fax: 506-452-7652
www.jacqueswhitford.com

Jacques
Whitford

Jacques
Whitford

TABLE OF CONTENTS

Page No.

1.0 HYDRODYNAMIC MODELLING 1
1.1 Introduction 1
1.2 Hydrodynamic Model Set-up 1
1.3 Model Input 2
1.3.1 Storage Elevation Curves 2
1.3.2 Freshwater Inflow 3
1.3.3 Tidal Hydrographs 3
1.4 Model Calibration 3
2.0 RATIONALE FOR THE PREDICTED FUTURE GEOMORPHOLOGICAL ENVIRONMENT 33

LIST OF TABLES

Page No.

Table B.1 Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides 7
Table B.2 Water Level Survey Data Downstream of Dam and Downstream at Fishway of Dam, May 6, 2004 18
Table B.3 Water Level Survey Data Upstream of the Dam in the Impoundment, May 6, 2004 19
Table B.4 Water Level Measurements at Eel River Area from for June 26, 2004 - Neap Tides 23
Table B.5 Water Level Survey Data June 26, 2004 29

LIST OF FIGURES

Page No.

Figure B.1 Comparison of Tidal Hydrographs for Tides in Eel Bay (former 3.2) 5
Figure B.2 Simulated and Observed Water Levels in the Estuary Below Dam 21
Figure B.3 Simulated and Observed Water Levels in the Impoundment at Eel River Dam 31

Jacques
Whitford

1.0 HYDRODYNAMIC MODELLING

1.1 Introduction

This section summarizes the modelling set-up, model-input and model calibration undertaken in support of the EIA.

The Town of Dalhousie constructed the Eel River dam in 1963 to secure a freshwater supply for major industries in the Dalhousie area. The dam is located approximately 600 m upstream of New Brunswick Route 134 at Eel River bar (Figure 1.1.1 in the EIA Report). It extends from the Eel River Bar First Nation on the north to the Blue Heron Campground/Park on the south. The ownership of the Eel River dam was eventually turned over to the Province of New Brunswick.

Since the construction of the Eel River dam, there have been significant changes in the surrounding environment. A number of investigations conducted to assess the conditions of the natural resources within the estuary and impoundment above the dam have concluded that the deterioration in these resources is largely attributable to the dam. Members of the Eel River Bar First Nation experienced a significant change to their way of life when these resources were lost (NBDSS, 2003).

Over the last few years, the Province of New Brunswick and the Eel River Bar First Nation have discussed the removal of the dam as a method to restore the estuary. In 2004, the Province contracted Jacques Whitford Limited to conduct an EIA study to evaluate the potential environmental effects associated with the removal of the Eel River dam. The Jacques Whitford Study Team undertook this component of the study to address the hydrodynamic, water quality, and morphological related issues as a result of the proposed Eel River dam removal. Results from this component study may also be used in the evaluation of the other environmental issues as part of the EIA study.

1.2 Hydrodynamic Model Set-up

In the hydrodynamic model set-up, the Eel River system below Eel River Crossing was conceptualized to consist of two storage components: the impoundment storage component and the Eel River estuary storage component. However, for total dam removal, the impoundment and Eel River estuary were combined into one storage component. Tidal level fluctuations in Eel Bay and freshwater inflow into the impoundment were considered as boundary conditions. The tidal inlet into the Eel River estuary was conceptualized as consisting of a section of open channel, whose capacity determined the rate of water level rise in the Eel River estuary, and subsequently the impoundment, in response to the tidal cycle in Eel Bay. Except for the tidal inlet, the remainder of the Eel River estuary was simulated as a reservoir, where the water surface was level.

Flow exchange across the Eel River dam was simulated differently for various modelling scenarios. Under existing conditions, tidal flow does not enter the impoundment, and fresh water flow is discharged into the Eel River estuary through the water control structure, including the gates and fishway. The discharge flow rate through the water control structure is dependent on the operation of the gates. Under the partial opening scenarios, the opening through the dam was simulated as a short section of channel through which tidal flow entered into and discharged from the impoundment. For the total removal scenario, the impoundment and the Eel River estuary were combined, and tidal exchange across the dam was not simulated.

Spreadsheet models were set up to represent the Eel River estuary for various dam removal scenarios. Each model was based on the water balance principle. For each time step through a tidal cycle, the volume of flow into and out of each of the two storage components was calculated based on current tidal water level, and the water level in the impoundment and Eel River estuary at the previous time step. A very small time step of no longer than 1.5 minutes was adopted to minimize computational error and model instability.

1.3 Model Input

Depending on the modelling scenarios considered, the input into the hydrodynamic model included the following:

- storage-elevation curves;
- freshwater inflow; and
- tide hydrographs.

The following discusses each of the data requirements to run the model.

1.3.1 Storage Elevation Curves

During the site visits conducted in June 2004, a total of 18 cross sections were surveyed, including 10 cross sections in the impoundment, and five cross sections in the Eel River estuary. Three cross sections were located in the area of the tidal inlet in an effort to evaluate the geometry and characteristics of the tidal inlet. The survey was conducted for the portion of the cross section below the water level. For the assessment area below the Eel River dam, the cross sections surveyed were lower than the high tide elevation, and it was necessary to estimate the cross section area up to the high tide elevation to satisfy the model input. This estimate was obtained by assuming the cross section width at the highest water level during the survey. As the cross section survey points do not necessarily follow a straight line, corrections were made by projecting the survey points for each cross section onto a straight line. The cross section locations, the cross sectional data (coordinates and elevations), and the cross section plots are presented in Appendix D. The cross section locations are also shown on Figure 3.2.4 in the EIA Report.

Using the cross section data, an elevation and storage relationship for the impoundment, the Eel River estuary, and the combined estuary, were developed, as presented in Figure 6.3.1 in the EIA Report. Under a maximum operating water level of 1.98 m the impoundment has a total storage volume of approximately 2.8 million m^3. Under mean tide conditions with a Higher High Water Level of 1.1 m, the Eel River estuary area has a storage volume of 0.59 million m^3. When the Eel River dam is removed, the combined storage in the estuary under mean tide conditions will be approximately 1.9 million m^3.

1.3.2 Freshwater Inflow

As discussed in Section 3.2.1 in the EIA Report, the mean annual flow at the Eel River dam is estimated to be 5 m^3/s. The 1:2 year flood flow, which is commonly considered in evaluating erosion and channel morphological changes and approximately corresponds to average annual spring flood, is estimated to be 60 m^3/s.

1.3.3 Tidal Hydrographs

The tidal water levels for characteristic tides in Eel Bay have been presented in Section 3.2.4 in the EIA Report. Tidal water level variation in the ocean typically follows a sine curve with duration for a tidal cycle of about 12.4 hours. The tidal water levels for large and mean tides for Dalhousie, as adopted for this study, are presented in Figure B.1.

1.4 Model Calibration

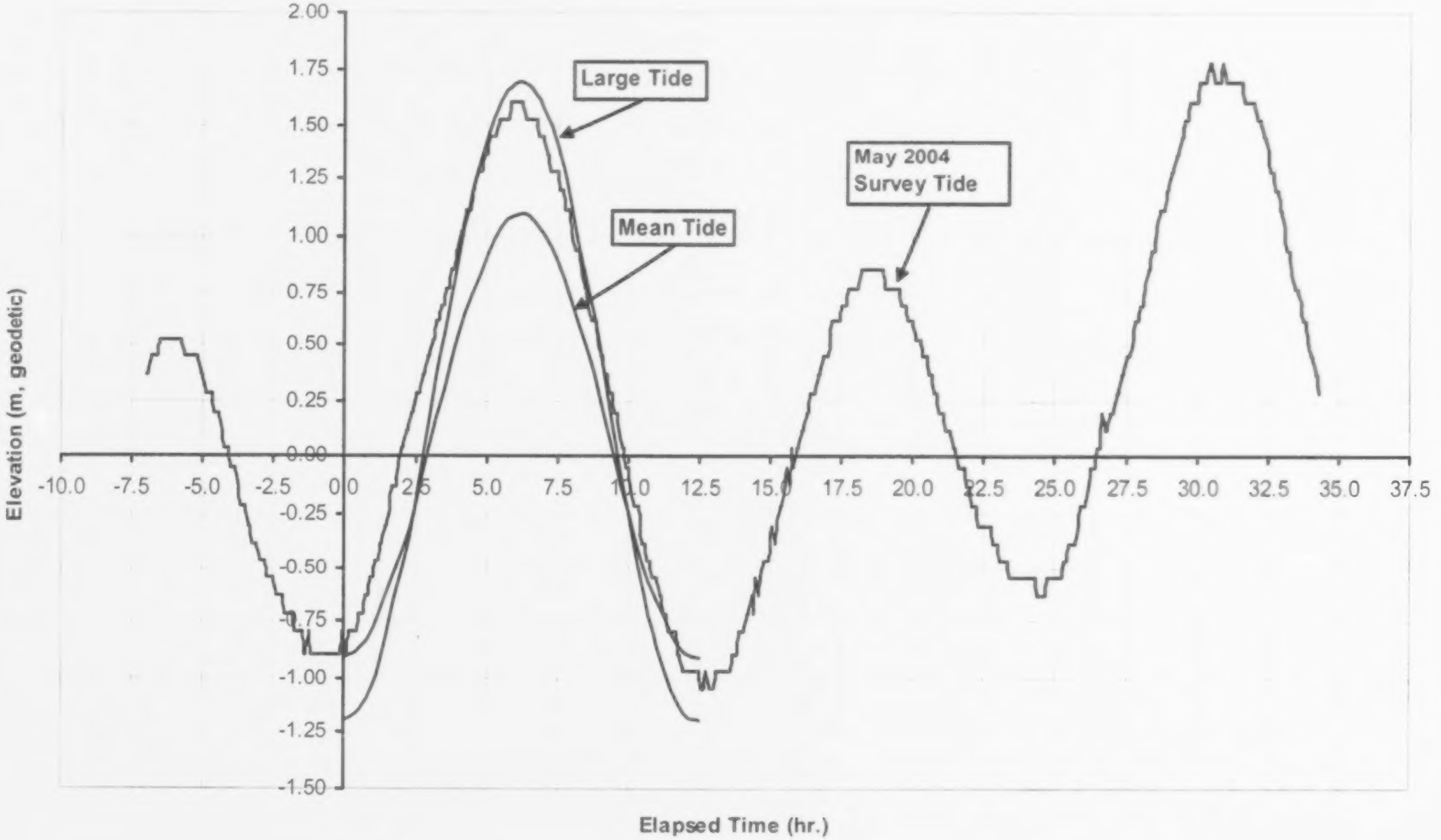
During the fieldwork conducted from May 4 to 10, 2004 by the Jacques Whitford Study Team, water level measurements were taken in the impoundment at a short distance upstream of the dam, in the Eel River estuary just below the dam, and in Eel Bay at selected locations. The water level measurements collected during the site visit have been summarized in Table B.1, B.2 and B.3. The tide conditions during the field visit were similar to a large tide, with Higher High Water Level in Eel Bay reaching 1.78 m. A comparison of the tidal water levels during the field visit with the large and mean tide as reported by Canadian Hydrographic Service is presented in Figure B.1.

The stream flow data for Eel River at Dundee for May, 2004 was obtained from Environment Canada. Inflow into the impoundment on May 6, 2004 was estimated to be approximately 16.4 m^3/s based on the total drainage area at the Eel River dam, which is a typical flow under spring runoff condition.

The gate operation was recorded during the site visit. On May 6, 2004, Gate 4 was opened approximately 1.25 m, from its sill elevation (-0.96 m). All the other gates were closed with four stop logs installed in Gates 2 and 3, and the weir section installed in Gate 1. However, the water level in the impoundment at the time was about 0.15 m higher than the top of the closed steel gates, and water was spilling into the Eel River estuary.

In the calibration simulation, measured tidal elevations in Eel Bay and estimated fresh water inflow into the impoundment were entered as boundary conditions. Discharge from the impoundment into the Eel River estuary through the water control structure is calculated as a function of the water level in the impoundment and the Eel River estuary.

<THIS PAGE IS INTENTIONALLY LEFT BLANK>



Comparison of Tidal Hydrographs for Tides in Eel Bay	Date: 12/16/2005	Scale:	**Eel River Dam** – ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **B.1**	NBDSS PROJECT No. YR101A

The calibration was conducted by adjusting the length of a 30 m wide conceptualized rectangular channel at the tidal inlet and Manning's roughness coefficient (Manning's "n") for this section of channel. The length of the tidal inlet channel was conceived to represent the section beyond which flow velocity was reduced to a negligible magnitude due to substantially increased cross sectional area in the Eel River estuary upstream of the inlet channel. It was determined that, by selecting a tidal inlet length of 400 m and a Manning's "n" of 0.040, the simulated water level closely resembles the observed water level in the Eel River estuary just below the dam and in the impoundment just above the dam.

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	**Eel Bay**
UTM Zone	**19U**
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
05/May/04 16:09:16	0.37
05/May/04 16:14:16	0.37
05/May/04 16:19:16	0.45
05/May/04 16:24:16	0.45
05/May/04 16:29:16	0.45
05/May/04 16:34:16	0.45
05/May/04 16:39:16	0.53
05/May/04 16:44:16	0.53
05/May/04 16:49:16	0.53
05/May/04 16:54:16	0.53
05/May/04 16:59:16	0.53
05/May/04 17:04:16	0.53
05/May/04 17:09:16	0.53
05/May/04 17:14:16	0.53
05/May/04 17:19:16	0.53
05/May/04 17:24:16	0.53
05/May/04 17:29:16	0.45
05/May/04 17:34:16	0.45
05/May/04 17:39:16	0.45
05/May/04 17:44:16	0.45
05/May/04 17:49:16	0.45
05/May/04 17:54:16	0.45
05/May/04 17:59:16	0.45
05/May/04 18:04:16	0.37
05/May/04 18:09:16	0.37
05/May/04 18:14:16	0.29
05/May/04 18:19:16	0.29
05/May/04 18:24:16	0.29
05/May/04 18:29:16	0.29
05/May/04 18:34:16	0.20
05/May/04 18:39:16	0.20
05/May/04 18:44:16	0.20
05/May/04 18:49:16	0.12
05/May/04 18:54:16	0.04
05/May/04 18:59:16	0.04
05/May/04 19:04:16	0.04
05/May/04 19:09:16	-0.05

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	19U
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
05/May/04 19:14:16	-0.05
05/May/04 19:19:16	-0.05
05/May/04 19:24:16	-0.13
05/May/04 19:29:16	-0.21
05/May/04 19:34:16	-0.21
05/May/04 19:39:16	-0.21
05/May/04 19:44:16	-0.30
05/May/04 19:49:16	-0.30
05/May/04 19:54:16	-0.38
05/May/04 19:59:16	-0.38
05/May/04 20:04:16	-0.38
05/May/04 20:09:16	-0.46
05/May/04 20:14:16	-0.46
05/May/04 20:19:16	-0.46
05/May/04 20:24:16	-0.54
05/May/04 20:29:16	-0.54
05/May/04 20:34:16	-0.54
05/May/04 20:39:16	-0.54
05/May/04 20:44:16	-0.63
05/May/04 20:49:16	-0.63
05/May/04 20:54:16	-0.63
05/May/04 20:59:16	-0.63
05/May/04 21:04:16	-0.71
05/May/04 21:09:16	-0.71
05/May/04 21:14:16	-0.71
05/May/04 21:19:16	-0.71
05/May/04 21:24:16	-0.79
05/May/04 21:29:16	-0.79
05/May/04 21:34:16	-0.79
05/May/04 21:39:16	-0.79
05/May/04 21:44:16	-0.88
05/May/04 21:49:16	-0.88
05/May/04 21:54:16	-0.79
05/May/04 21:59:16	-0.88
05/May/04 22:04:16	-0.88
05/May/04 22:09:16	-0.88
05/May/04 22:14:16	-0.88
05/May/04 22:19:16	-0.88
05/May/04 22:24:16	-0.88
05/May/04 22:29:16	-0.88
05/May/04 22:34:16	-0.88
05/May/04 22:39:16	-0.88
05/May/04 22:44:16	-0.88
05/May/04 22:49:16	-0.88
05/May/04 22:54:16	-0.88
05/May/04 22:59:16	-0.88
05/May/04 23:04:16	-0.79
05/May/04 23:09:16	-0.88

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	**19U**
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
05/May/04 23:14:16	-0.88
05/May/04 23:19:16	-0.79
05/May/04 23:24:16	-0.79
05/May/04 23:29:16	-0.79
05/May/04 23:34:16	-0.79
05/May/04 23:39:16	-0.71
05/May/04 23:44:16	-0.71
05/May/04 23:49:16	-0.71
05/May/04 23:54:16	-0.63
05/May/04 23:59:16	-0.63
06/May/04 00:04:16	-0.54
06/May/04 00:09:16	-0.54
06/May/04 00:14:16	-0.46
06/May/04 00:19:16	-0.46
06/May/04 00:24:16	-0.38
06/May/04 00:29:16	-0.38
06/May/04 00:34:16	-0.30
06/May/04 00:39:16	-0.30
06/May/04 00:44:16	-0.21
06/May/04 00:49:16	-0.13
06/May/04 00:54:16	-0.13
06/May/04 00:59:16	-0.13
06/May/04 01:04:16	-0.05
06/May/04 01:09:16	0.04
06/May/04 01:14:16	0.04
06/May/04 01:19:16	0.12
06/May/04 01:24:16	0.12
06/May/04 01:29:16	0.20
06/May/04 01:34:16	0.20
06/May/04 01:39:16	0.29
06/May/04 01:44:16	0.29
06/May/04 01:49:16	0.29
06/May/04 01:54:16	0.37
06/May/04 01:59:16	0.37
06/May/04 02:04:16	0.45
06/May/04 02:09:16	0.45
06/May/04 02:14:16	0.53
06/May/04 02:19:16	0.53
06/May/04 02:24:16	0.62
06/May/04 02:29:16	0.62
06/May/04 02:34:16	0.70
06/May/04 02:39:16	0.70
06/May/04 02:44:16	0.78
06/May/04 02:49:16	0.78
06/May/04 02:54:16	0.87
06/May/04 02:59:16	0.87
06/May/04 03:04:16	0.95
06/May/04 03:09:16	0.95

Table B.1 Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides
Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	**Eel Bay**
UTM Zone	**19U**
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
06/May/04 03:14:16	1.03
06/May/04 03:19:16	1.03
06/May/04 03:24:16	1.12
06/May/04 03:29:16	1.12
06/May/04 03:34:16	1.12
06/May/04 03:39:16	1.20
06/May/04 03:44:16	1.20
06/May/04 03:49:16	1.28
06/May/04 03:54:16	1.28
06/May/04 03:59:16	1.28
06/May/04 04:04:16	1.36
06/May/04 04:09:16	1.36
06/May/04 04:14:16	1.45
06/May/04 04:19:16	1.45
06/May/04 04:24:16	1.45
06/May/04 04:29:16	1.45
06/May/04 04:34:16	1.53
06/May/04 04:39:16	1.53
06/May/04 04:44:16	1.53
06/May/04 04:49:16	1.53
06/May/04 04:54:16	1.53
06/May/04 04:59:16	1.61
06/May/04 05:04:16	1.61
06/May/04 05:09:16	1.61
06/May/04 05:14:16	1.61
06/May/04 05:19:16	1.61
06/May/04 05:24:16	1.61
06/May/04 05:29:16	1.53
06/May/04 05:34:16	1.53
06/May/04 05:39:16	1.53
06/May/04 05:44:16	1.53
06/May/04 05:49:16	1.53
06/May/04 05:54:16	1.53
06/May/04 05:59:16	1.45
06/May/04 06:04:16	1.45
06/May/04 06:09:16	1.45
06/May/04 06:14:16	1.36
06/May/04 06:19:16	1.36
06/May/04 06:24:16	1.28
06/May/04 06:29:16	1.28
06/May/04 06:34:16	1.28
06/May/04 06:39:16	1.28
06/May/04 06:44:16	1.20
06/May/04 06:49:16	1.20
06/May/04 06:54:16	1.12
06/May/04 06:59:16	1.12
06/May/04 07:04:16	1.12
06/May/04 07:09:16	1.03

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	19U
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
06/May/04 07:14:16	0.95
06/May/04 07:19:16	0.95
06/May/04 07:24:16	0.95
06/May/04 07:29:16	0.87
06/May/04 07:34:16	0.78
06/May/04 07:39:16	0.78
06/May/04 07:44:16	0.70
06/May/04 07:49:16	0.62
06/May/04 07:54:16	0.62
06/May/04 07:59:16	0.62
06/May/04 08:04:16	0.53
06/May/04 08:09:16	0.45
06/May/04 08:14:16	0.45
06/May/04 08:19:16	0.37
06/May/04 08:24:16	0.37
06/May/04 08:29:16	0.29
06/May/04 08:34:16	0.29
06/May/04 08:39:16	0.20
06/May/04 08:44:16	0.20
06/May/04 08:49:16	0.12
06/May/04 08:54:16	0.04
06/May/04 08:59:16	0.04
06/May/04 09:04:16	-0.05
06/May/04 09:09:16	-0.05
06/May/04 09:14:16	-0.13
06/May/04 09:19:16	-0.21
06/May/04 09:24:16	-0.21
06/May/04 09:29:16	-0.21
06/May/04 09:34:16	-0.30
06/May/04 09:39:16	-0.38
06/May/04 09:44:16	-0.38
06/May/04 09:49:16	-0.46
06/May/04 09:54:16	-0.46
06/May/04 09:59:16	-0.54
06/May/04 10:04:16	-0.54
06/May/04 10:09:16	-0.54
06/May/04 10:14:16	-0.63
06/May/04 10:19:16	-0.63
06/May/04 10:24:16	-0.71
06/May/04 10:29:16	-0.71
06/May/04 10:34:16	-0.79
06/May/04 10:39:16	-0.79
06/May/04 10:44:16	-0.79
06/May/04 10:49:16	-0.79
06/May/04 10:54:16	-0.88
06/May/04 10:59:16	-0.88
06/May/04 11:04:16	-0.96
06/May/04 11:09:16	-0.96

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	**19U**
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
06/May/04 11:14:16	-0.96
06/May/04 11:19:16	-0.96
06/May/04 11:24:16	-0.96
06/May/04 11:29:16	-0.96
06/May/04 11:34:16	-0.96
06/May/04 11:39:16	-0.96
06/May/04 11:44:16	-1.04
06/May/04 11:49:16	-1.04
06/May/04 11:54:16	-0.96
06/May/04 11:59:16	-1.04
06/May/04 12:04:16	-1.04
06/May/04 12:09:16	-1.04
06/May/04 12:14:16	-0.96
06/May/04 12:19:16	-0.96
06/May/04 12:24:16	-0.96
06/May/04 12:29:16	-0.96
06/May/04 12:34:16	-0.96
06/May/04 12:39:16	-0.96
06/May/04 12:44:16	-0.96
06/May/04 12:49:16	-0.88
06/May/04 12:54:16	-0.88
06/May/04 12:59:16	-0.88
06/May/04 13:04:16	-0.79
06/May/04 13:09:16	-0.79
06/May/04 13:14:16	-0.79
06/May/04 13:19:16	-0.71
06/May/04 13:24:16	-0.71
06/May/04 13:29:16	-0.63
06/May/04 13:34:16	-0.71
06/May/04 13:39:16	-0.54
06/May/04 13:44:16	-0.63
06/May/04 13:49:16	-0.54
06/May/04 13:54:16	-0.46
06/May/04 13:59:16	-0.46
06/May/04 14:04:16	-0.46
06/May/04 14:09:16	-0.38
06/May/04 14:14:16	-0.30
06/May/04 14:19:16	-0.38
06/May/04 14:24:16	-0.30
06/May/04 14:29:16	-0.21
06/May/04 14:34:16	-0.21
06/May/04 14:39:16	-0.13
06/May/04 14:44:16	-0.05
06/May/04 14:49:16	-0.13
06/May/04 14:54:16	0.04
06/May/04 14:59:16	-0.05
06/May/04 15:04:16	0.04
06/May/04 15:09:16	0.04

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	19U
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
06/May/04 15:14:16	0.12
06/May/04 15:19:16	0.12
06/May/04 15:24:16	0.20
06/May/04 15:29:16	0.20
06/May/04 15:34:16	0.29
06/May/04 15:39:16	0.29
06/May/04 15:44:16	0.29
06/May/04 15:49:16	0.37
06/May/04 15:54:16	0.37
06/May/04 15:59:16	0.45
06/May/04 16:04:16	0.45
06/May/04 16:09:16	0.45
06/May/04 16:14:16	0.53
06/May/04 16:19:16	0.62
06/May/04 16:24:16	0.62
06/May/04 16:29:16	0.62
06/May/04 16:34:16	0.62
06/May/04 16:39:16	0.70
06/May/04 16:44:16	0.70
06/May/04 16:49:16	0.70
06/May/04 16:54:16	0.78
06/May/04 16:59:16	0.78
06/May/04 17:04:16	0.78
06/May/04 17:09:16	0.78
06/May/04 17:14:16	0.78
06/May/04 17:19:16	0.87
06/May/04 17:24:16	0.87
06/May/04 17:29:16	0.87
06/May/04 17:34:16	0.87
06/May/04 17:39:16	0.87
06/May/04 17:44:16	0.87
06/May/04 17:49:16	0.87
06/May/04 17:54:16	0.87
06/May/04 17:59:16	0.87
06/May/04 18:04:16	0.87
06/May/04 18:09:16	0.78
06/May/04 18:14:16	0.78
06/May/04 18:19:16	0.78
06/May/04 18:24:16	0.78
06/May/04 18:29:16	0.78
06/May/04 18:34:16	0.78
06/May/04 18:39:16	0.78
06/May/04 18:44:16	0.70
06/May/04 18:49:16	0.70
06/May/04 18:54:16	0.70
06/May/04 18:59:16	0.62
06/May/04 19:04:16	0.62
06/May/04 19:09:16	0.62

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	19U
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
06/May/04 19:14:16	0.53
06/May/04 19:19:16	0.53
06/May/04 19:24:16	0.53
06/May/04 19:29:16	0.45
06/May/04 19:34:16	0.45
06/May/04 19:39:16	0.45
06/May/04 19:44:16	0.37
06/May/04 19:49:16	0.37
06/May/04 19:54:16	0.29
06/May/04 19:59:16	0.29
06/May/04 20:04:16	0.20
06/May/04 20:09:16	0.20
06/May/04 20:14:16	0.20
06/May/04 20:19:16	0.12
06/May/04 20:24:16	0.12
06/May/04 20:29:16	0.12
06/May/04 20:34:16	0.04
06/May/04 20:39:16	0.04
06/May/04 20:44:16	-0.05
06/May/04 20:49:16	-0.05
06/May/04 20:54:16	-0.05
06/May/04 20:59:16	-0.05
06/May/04 21:04:16	-0.13
06/May/04 21:09:16	-0.13
06/May/04 21:14:16	-0.21
06/May/04 21:19:16	-0.21
06/May/04 21:24:16	-0.21
06/May/04 21:29:16	-0.30
06/May/04 21:34:16	-0.30
06/May/04 21:39:16	-0.30
06/May/04 21:44:16	-0.30
06/May/04 21:49:16	-0.30
06/May/04 21:54:16	-0.30
06/May/04 21:59:16	-0.38
06/May/04 22:04:16	-0.38
06/May/04 22:09:16	-0.38
06/May/04 22:14:16	-0.46
06/May/04 22:19:16	-0.46
06/May/04 22:24:16	-0.46
06/May/04 22:29:16	-0.46
06/May/04 22:34:16	-0.54
06/May/04 22:39:16	-0.54
06/May/04 22:44:16	-0.54
06/May/04 22:49:16	-0.54
06/May/04 22:54:16	-0.54
06/May/04 22:59:16	-0.54
06/May/04 23:04:16	-0.54
06/May/04 23:09:16	-0.54

Table B.1 Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	**Eel Bay**
UTM Zone	**19U**
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
06/May/04 23:14:16	-0.54
06/May/04 23:19:16	-0.54
06/May/04 23:24:16	-0.54
06/May/04 23:29:16	-0.54
06/May/04 23:34:16	-0.63
06/May/04 23:39:16	-0.63
06/May/04 23:44:16	-0.63
06/May/04 23:49:16	-0.63
06/May/04 23:54:16	-0.54
06/May/04 23:59:16	-0.54
07/May/04 00:04:16	-0.54
07/May/04 00:09:16	-0.54
07/May/04 00:14:16	-0.54
07/May/04 00:19:16	-0.54
07/May/04 00:24:16	-0.54
07/May/04 00:29:16	-0.46
07/May/04 00:34:16	-0.46
07/May/04 00:39:16	-0.38
07/May/04 00:44:16	-0.38
07/May/04 00:49:16	-0.38
07/May/04 00:54:16	-0.38
07/May/04 00:59:16	-0.30
07/May/04 01:04:16	-0.21
07/May/04 01:09:16	-0.21
07/May/04 01:14:16	-0.21
07/May/04 01:19:16	-0.13
07/May/04 01:24:16	-0.05
07/May/04 01:29:16	-0.05
07/May/04 01:34:16	-0.05
07/May/04 01:39:16	0.04
07/May/04 01:44:16	0.04
07/May/04 01:49:16	0.20
07/May/04 01:54:16	0.12
07/May/04 01:59:16	0.12
07/May/04 02:04:16	0.20
07/May/04 02:09:16	0.20
07/May/04 02:14:16	0.20
07/May/04 02:19:16	0.29
07/May/04 02:24:16	0.29
07/May/04 02:29:16	0.37
07/May/04 02:34:16	0.37
07/May/04 02:39:16	0.45
07/May/04 02:44:16	0.45
07/May/04 02:49:16	0.45
07/May/04 02:54:16	0.53
07/May/04 02:59:16	0.62
07/May/04 03:04:16	0.62
07/May/04 03:09:16	0.70

Table B.1 Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay
UTM Zone	19U
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
07/May/04 03:14:16	0.70
07/May/04 03:19:16	0.78
07/May/04 03:24:16	0.87
07/May/04 03:29:16	0.87
07/May/04 03:34:16	0.95
07/May/04 03:39:16	0.95
07/May/04 03:44:16	1.03
07/May/04 03:49:16	1.12
07/May/04 03:54:16	1.12
07/May/04 03:59:16	1.12
07/May/04 04:04:16	1.20
07/May/04 04:09:16	1.20
07/May/04 04:14:16	1.28
07/May/04 04:19:16	1.28
07/May/04 04:24:16	1.36
07/May/04 04:29:16	1.36
07/May/04 04:34:16	1.45
07/May/04 04:39:16	1.45
07/May/04 04:44:16	1.53
07/May/04 04:49:16	1.53
07/May/04 04:54:16	1.61
07/May/04 04:59:16	1.61
07/May/04 05:04:16	1.61
07/May/04 05:09:16	1.61
07/May/04 05:14:16	1.70
07/May/04 05:19:16	1.70
07/May/04 05:24:16	1.70
07/May/04 05:29:16	1.70
07/May/04 05:34:16	1.78
07/May/04 05:39:16	1.78
07/May/04 05:44:16	1.70
07/May/04 05:49:16	1.70
07/May/04 05:54:16	1.70
07/May/04 05:59:16	1.70
07/May/04 06:04:16	1.78
07/May/04 06:09:16	1.70
07/May/04 06:14:16	1.70
07/May/04 06:19:16	1.70
07/May/04 06:24:16	1.70
07/May/04 06:29:16	1.70
07/May/04 06:34:16	1.70
07/May/04 06:39:16	1.70
07/May/04 06:44:16	1.70
07/May/04 06:49:16	1.61
07/May/04 06:54:16	1.61
07/May/04 06:59:16	1.61
07/May/04 07:04:16	1.61
07/May/04 07:09:16	1.61

Table B.1 **Water Level Measurements at Eel River Area from May 5-7, 2004 - Spring Tides Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m**

STATION	Eel Bay
UTM Zone	**19U**
Easting	697034
Northing	5324517
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
07/May/04 07:14:16	1.53
07/May/04 07:19:16	1.53
07/May/04 07:24:16	1.53
07/May/04 07:29:16	1.45
07/May/04 07:34:16	1.45
07/May/04 07:39:16	1.36
07/May/04 07:44:16	1.28
07/May/04 07:49:16	1.28
07/May/04 07:54:16	1.20
07/May/04 07:59:16	1.20
07/May/04 08:04:16	1.12
07/May/04 08:09:16	1.12
07/May/04 08:14:16	1.03
07/May/04 08:19:16	0.95
07/May/04 08:24:16	0.95
07/May/04 08:29:16	0.87
07/May/04 08:34:16	0.78
07/May/04 08:39:16	0.78
07/May/04 08:44:16	0.78
07/May/04 08:49:16	0.70
07/May/04 08:54:16	0.62
07/May/04 08:59:16	0.62
07/May/04 09:04:16	0.53
07/May/04 09:09:16	0.45
07/May/04 09:14:16	0.45
07/May/04 09:19:16	0.37
07/May/04 09:24:16	0.37
07/May/04 09:29:16	0.29

Legend: dd-mm-yyday-month-year
hh:mm:ss hour-minute-second

Water level survey data downstream of the dam and downstream at the fishway of the dam are presented in Table B.2 below.

Table B.2 Water Level Survey Data Downstream of Dam and Downstream at Fishway of Dam, May 6, 2004

STATION	Downstream of Dam in Estuary	STATION	Downstream @ Fishway of Dam
UTM Zone	**19U**	**UTM Zone**	**19U**
Easting	695884	**Easting**	695697
Northing	5321763	**Northing**	5321754
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
06/May/04 06:30:00	1.40	06/May/04 07:47:00	0.98
06/May/04 07:00:00	1.24	06/May/04 08:07:00	0.77
06/May/04 07:30:00	1.10	06/May/04 08:39:00	0.73
06/May/04 08:00:00	0.93	06/May/04 09:08:00	0.67
06/May/04 09:01:00	0.61	06/May/04 09:39:00	0.57
06/May/04 09:31:00	0.56	06/May/04 10:26:00	0.57
06/May/04 10:00:00	0.47	06/May/04 10:45:00	0.55
06/May/04 10:32:00	0.52	06/May/04 11:09:00	0.53
06/May/04 11:00:00	0.47	06/May/04 11:41:00	0.45
06/May/04 11:32:00	0.45	06/May/04 12:10:00	0.43
06/May/04 12:03:00	0.43	06/May/04 12:41:00	0.43
06/May/04 12:33:00	0.42	06/May/04 13:08:00	0.43
06/May/04 13:02:00	0.41	06/May/04 13:38:00	0.43
06/May/04 13:32:00	0.40	06/May/04 14:07:00	0.43
06/May/04 14:01:00	0.40	06/May/04 14:38:00	0.43
06/May/04 14:31:00	0.40	06/May/04 15:08:00	0.43
06/May/04 15:02:00	0.38	06/May/04 15:48:00	0.43
06/May/04 15:33:00	0.38	06/May/04 16:10:00	0.43
06/May/04 16:03:00	0.40	06/May/04 16:37:00	0.53
06/May/04 16:31:00	0.52	06/May/04 17:08:00	0.71
06/May/04 17:02:00	0.70	06/May/04 17:39:00	0.91
06/May/04 17:33:00	0.88	06/May/04 18:07:00	0.91
06/May/04 18:00:00	0.88	06/May/04 18:38:00	0.85
06/May/04 18:31:00	0.86	06/May/04 19:06:00	0.73
06/May/04 19:01:00	0.79	06/May/04 19:37:00	0.67
06/May/04 19:31:00	0.70		

Legend: dd-mm-yyday-month-year
hh:mm:ss hour-minute-second

Table B.3 summarizes water level survey data upstream of the dam in the impoundment.

Table B.3 Water Level Survey Data Upstream of the Dam in the Impoundment, May 6, 2004

STATION	**Upstream of the Dam in the Impoundment**
UTM Zone	**19U**
Easting	695697
Northing	5321754
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**
06/May/04 06:30:00	1.96
06/May/04 07:00:00	1.96
06/May/04 08:00:00	1.92
06/May/04 08:36:00	1.92
06/May/04 09:05:00	1.92
06/May/04 09:34:00	1.92
06/May/04 10:16:00	1.91
06/May/04 10:42:00	1.91
06/May/04 11:02:00	1.91
06/May/04 11:39:00	1.88
06/May/04 12:08:00	1.90
06/May/04 12:36:00	1.89
06/May/04 13:06:00	1.88
06/May/04 13:35:00	1.88
06/May/04 14:05:00	1.87
06/May/04 14:36:00	1.87
06/May/04 15:05:00	1.86
06/May/04 15:37:00	1.85
06/May/04 16:08:00	1.84
06/May/04 16:35:00	1.84
06/May/04 17:06:00	1.84
06/May/04 17:36:00	1.83
06/May/04 18:04:00	1.82
06/May/04 18:36:00	1.82
06/May/04 19:04:00	1.82
06/May/04 19:34:00	1.81

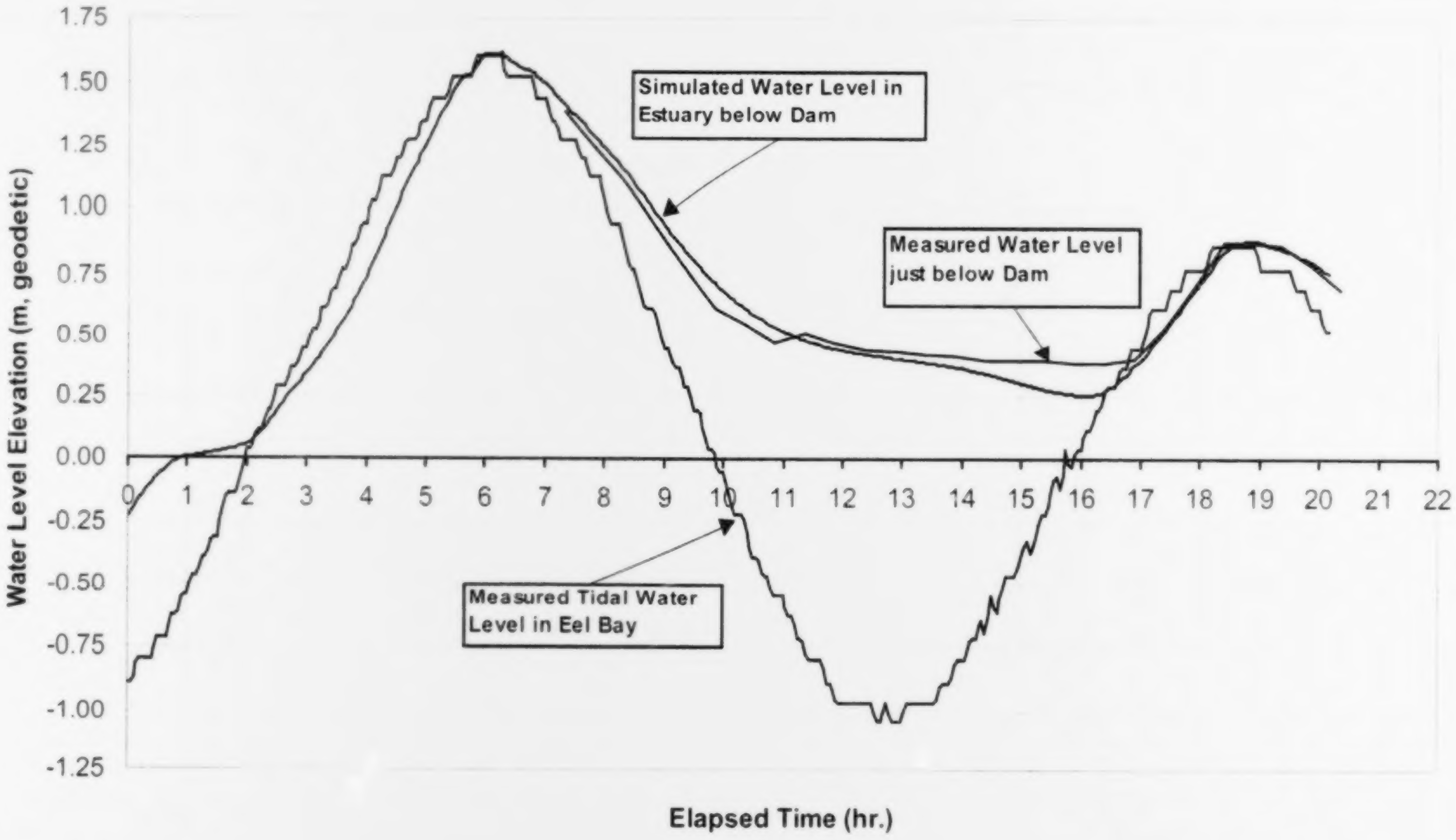
Legend: dd-mm-yyday-month-year
hh:mm:ss hour-minute-second

A comparison of the simulated water levels in the Eel River estuary with observed water levels is presented in Figure B.2. A comparison of the simulated water level with the observed water level in the impoundment is presented in Figure B.3.

During the fieldwork from June 22 to June 30, the Jacques Whitford Study Team collected additional water level measurements. On June 26, water level measurements were collected in the impoundment, the Eel River estuary, and the Eel Bay. These measurements were taken during a small tide, with peak tide elevations reaching 0.81 and 0.90 respectively for the two tidal cycles of the day. Both tides were smaller than the average tide for Eel Bay. The water level in the impoundment at the time was approximately 2.0 m. The water level survey data for June 26 as obtained by the Jacques Whitford Study Team is included in Table B.4 and B.5.

The water level survey data obtained for June 26 was used to verify the calibrated hydrodynamic model for low tide conditions. The water level in the estuary was simulated using the same hydraulic parameters determined in the calibration. It was found that the simulated water level in the estuary was in good agreement with the measured water level.

It is understood that the developed hydrodynamic model would primarily be used to evaluate the average and high flow conditions resulting from high freshwater flow and/or large tide. The model calibration establishes that the hydrodynamic model is acceptable for large tide conditions. The verification for low tide conditions establishes that the hydrodynamic model is acceptable for the range of tide typically encountered in Eel Bay.



Simulated and Observed Water Levels in the Estuary Below Dam	Date: 12/16/2005	Scale:	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **B.2**	NBDSS PROJECT No. YR101A

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**

Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	**UTM Zone**	19U
Easting	697018	**Easting**	695943
Northing	5324478	**Northing**	5323101
Date(dd-mm-yy) Time(hh:mm:ss	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 00:00:56	0.44	26/Jun/04 00:03:32	0.53
26/Jun/04 00:05:56	0.44	26/Jun/04 00:08:32	0.53
26/Jun/04 00:10:56	0.35	26/Jun/04 00:13:32	0.53
26/Jun/04 00:15:56	0.35	26/Jun/04 00:18:32	0.53
26/Jun/04 00:20:56	0.35	26/Jun/04 00:23:32	0.44
26/Jun/04 00:25:56	0.35	26/Jun/04 00:28:32	0.44
26/Jun/04 00:30:56	0.35	26/Jun/04 00:33:32	0.44
26/Jun/04 00:35:56	0.26	26/Jun/04 00:38:32	0.36
26/Jun/04 00:40:56	0.26	26/Jun/04 00:43:32	0.36
26/Jun/04 00:45:56	0.26	26/Jun/04 00:48:32	0.36
26/Jun/04 00:50:56	0.17	26/Jun/04 00:53:32	0.36
26/Jun/04 00:55:56	0.08	26/Jun/04 00:58:32	0.36
26/Jun/04 01:00:56	0.17	26/Jun/04 01:03:32	0.28
26/Jun/04 01:05:56	0.08	26/Jun/04 01:08:32	0.28
26/Jun/04 01:10:56	0.08	26/Jun/04 01:13:32	0.28
26/Jun/04 01:15:56	0.08	26/Jun/04 01:18:32	0.28
26/Jun/04 01:20:56	-0.01	26/Jun/04 01:23:32	0.20
26/Jun/04 01:25:56	-0.01	26/Jun/04 01:28:32	0.20
26/Jun/04 01:30:56	-0.01	26/Jun/04 01:33:32	0.20
26/Jun/04 01:35:56	-0.01	26/Jun/04 01:38:32	0.20
26/Jun/04 01:40:56	-0.10	26/Jun/04 01:43:32	0.20
26/Jun/04 01:45:56	-0.10	26/Jun/04 01:48:32	0.20
26/Jun/04 01:50:56	-0.10	26/Jun/04 01:53:32	0.20
26/Jun/04 01:55:56	-0.19	26/Jun/04 01:58:32	0.20
26/Jun/04 02:00:56	-0.19	26/Jun/04 02:03:32	0.11
26/Jun/04 02:05:56	-0.19	26/Jun/04 02:08:32	0.11
26/Jun/04 02:10:56	-0.19	26/Jun/04 02:13:32	0.20
26/Jun/04 02:15:56	-0.19	26/Jun/04 02:18:32	0.11
26/Jun/04 02:20:56	-0.19	26/Jun/04 02:23:32	0.11
26/Jun/04 02:25:56	-0.19	26/Jun/04 02:28:32	0.11
26/Jun/04 02:30:56	-0.28	26/Jun/04 02:33:32	0.11
26/Jun/04 02:35:56	-0.28	26/Jun/04 02:38:32	0.11
26/Jun/04 02:40:56	-0.28	26/Jun/04 02:43:32	0.11
26/Jun/04 02:45:56	-0.28	26/Jun/04 02:48:32	0.11
26/Jun/04 02:50:56	-0.28	26/Jun/04 02:53:32	0.11
26/Jun/04 02:55:56	-0.28	26/Jun/04 02:58:32	0.11
26/Jun/04 03:00:56	-0.28	26/Jun/04 03:03:32	0.11
26/Jun/04 03:05:56	-0.28	26/Jun/04 03:08:32	0.11
26/Jun/04 03:10:56	-0.28	26/Jun/04 03:13:32	0.11
26/Jun/04 03:15:56	-0.28	26/Jun/04 03:18:32	0.03
26/Jun/04 03:20:56	-0.28	26/Jun/04 03:23:32	0.03
26/Jun/04 03:25:56	-0.28	26/Jun/04 03:28:32	0.03
26/Jun/04 03:30:56	-0.28	26/Jun/04 03:33:32	0.03
26/Jun/04 03:35:56	-0.28	26/Jun/04 03:38:32	0.03

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**

Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	UTM Zone	19U
Easting	697018	Easting	695943
Northing	5324478	Northing	5323101
Date(dd-mm-yy) Time(hh:mm:ss	Water Level Elevation (m, geodetic)	Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
26/Jun/04 03:40:56	-0.37	26/Jun/04 03:43:32	0.03
26/Jun/04 03:45:56	-0.28	26/Jun/04 03:48:32	0.03
26/Jun/04 03:50:56	-0.28	26/Jun/04 03:53:32	0.03
26/Jun/04 03:55:56	-0.37	26/Jun/04 03:58:32	0.03
26/Jun/04 04:00:56	-0.28	26/Jun/04 04:03:32	0.03
26/Jun/04 04:05:56	-0.28	26/Jun/04 04:08:32	0.03
26/Jun/04 04:10:56	-0.28	26/Jun/04 04:13:32	0.03
26/Jun/04 04:15:56	-0.28	26/Jun/04 04:18:32	0.03
26/Jun/04 04:20:56	-0.28	26/Jun/04 04:23:32	0.03
26/Jun/04 04:25:56	-0.28	26/Jun/04 04:28:32	0.03
26/Jun/04 04:30:56	-0.19	26/Jun/04 04:33:32	0.03
26/Jun/04 04:35:56	-0.19	26/Jun/04 04:38:32	0.03
26/Jun/04 04:40:56	-0.19	26/Jun/04 04:43:32	-0.05
26/Jun/04 04:45:56	-0.19	26/Jun/04 04:48:32	0.03
26/Jun/04 04:50:56	-0.19	26/Jun/04 04:53:32	-0.05
26/Jun/04 04:55:56	-0.19	26/Jun/04 04:58:32	-0.05
26/Jun/04 05:00:56	-0.19	26/Jun/04 05:03:32	0.03
26/Jun/04 05:05:56	-0.19	26/Jun/04 05:08:32	-0.05
26/Jun/04 05:10:56	-0.10	26/Jun/04 05:13:32	0.03
26/Jun/04 05:15:56	-0.10	26/Jun/04 05:18:32	-0.05
26/Jun/04 05:20:56	-0.10	26/Jun/04 05:23:32	-0.05
26/Jun/04 05:25:56	-0.10	26/Jun/04 05:28:32	-0.05
26/Jun/04 05:30:56	-0.10	26/Jun/04 05:33:32	0.03
26/Jun/04 05:35:56	-0.10	26/Jun/04 05:38:32	0.03
26/Jun/04 05:40:56	-0.01	26/Jun/04 05:43:32	0.03
26/Jun/04 05:45:56	-0.01	26/Jun/04 05:48:32	0.03
26/Jun/04 05:50:56	-0.01	26/Jun/04 05:53:32	0.03
26/Jun/04 05:55:56	-0.01	26/Jun/04 05:58:32	0.03
26/Jun/04 06:00:56	-0.01	26/Jun/04 06:03:32	0.03
26/Jun/04 06:05:56	0.08	26/Jun/04 06:08:32	0.03
26/Jun/04 06:10:56	0.08	26/Jun/04 06:13:32	0.03
26/Jun/04 06:15:56	0.08	26/Jun/04 06:18:32	0.03
26/Jun/04 06:20:56	0.08	26/Jun/04 06:23:32	0.03
26/Jun/04 06:25:56	0.08	26/Jun/04 06:28:32	0.11
26/Jun/04 06:30:56	0.08	26/Jun/04 06:33:32	0.11
26/Jun/04 06:35:56	0.17	26/Jun/04 06:38:32	0.11
26/Jun/04 06:40:56	0.17	26/Jun/04 06:43:32	0.20
26/Jun/04 06:45:56	0.17	26/Jun/04 06:48:32	0.11
26/Jun/04 06:50:56	0.26	26/Jun/04 06:53:32	0.20
26/Jun/04 06:55:56	0.26	26/Jun/04 06:58:32	0.20
26/Jun/04 07:00:56	0.26	26/Jun/04 07:03:32	0.20
26/Jun/04 07:05:56	0.26	26/Jun/04 07:08:32	0.20
26/Jun/04 07:10:56	0.26	26/Jun/04 07:13:32	0.20
26/Jun/04 07:15:56	0.26	26/Jun/04 07:18:32	0.28
26/Jun/04 07:20:56	0.26	26/Jun/04 07:23:32	0.28
26/Jun/04 07:25:56	0.35	26/Jun/04 07:28:32	0.28

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**

Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	**UTM Zone**	19U
Easting	697018	**Easting**	695943
Northing	5324478	**Northing**	5323101
Date(dd-mm-yy) Time(hh:mm:ss	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 07:30:56	0.35	26/Jun/04 07:33:32	0.28
26/Jun/04 07:35:56	0.35	26/Jun/04 07:38:32	0.28
26/Jun/04 07:40:56	0.44	26/Jun/04 07:43:32	0.28
26/Jun/04 07:45:56	0.35	26/Jun/04 07:48:32	0.36
26/Jun/04 07:50:56	0.44	26/Jun/04 07:53:32	0.36
26/Jun/04 07:55:56	0.44	26/Jun/04 07:58:32	0.44
26/Jun/04 08:00:56	0.44	26/Jun/04 08:03:32	0.36
26/Jun/04 08:05:56	0.44	26/Jun/04 08:08:32	0.36
26/Jun/04 08:10:56	0.54	26/Jun/04 08:13:32	0.44
26/Jun/04 08:15:56	0.54	26/Jun/04 08:18:32	0.44
26/Jun/04 08:20:56	0.54	26/Jun/04 08:23:32	0.44
26/Jun/04 08:25:56	0.54	26/Jun/04 08:28:32	0.44
26/Jun/04 08:30:56	0.63	26/Jun/04 08:33:32	0.53
26/Jun/04 08:35:56	0.63	26/Jun/04 08:38:32	0.53
26/Jun/04 08:40:56	0.63	26/Jun/04 08:43:32	0.53
26/Jun/04 08:45:56	0.63	26/Jun/04 08:48:32	0.53
26/Jun/04 08:50:56	0.72	26/Jun/04 08:53:32	0.53
26/Jun/04 08:55:56	0.63	26/Jun/04 08:58:32	0.61
26/Jun/04 09:00:56	0.72	26/Jun/04 09:03:32	0.61
26/Jun/04 09:05:56	0.72	26/Jun/04 09:08:32	0.61
26/Jun/04 09:10:56	0.72	26/Jun/04 09:13:32	0.61
26/Jun/04 09:15:56	0.72	26/Jun/04 09:18:32	0.61
26/Jun/04 09:20:56	0.72	26/Jun/04 09:23:32	0.61
26/Jun/04 09:25:56	0.72	26/Jun/04 09:28:32	0.69
26/Jun/04 09:30:56	0.72	26/Jun/04 09:33:32	0.69
26/Jun/04 09:35:56	0.81	26/Jun/04 09:38:32	0.69
26/Jun/04 09:40:56	0.72	26/Jun/04 09:43:32	0.69
26/Jun/04 09:45:56	0.72	26/Jun/04 09:48:32	0.69
26/Jun/04 09:50:56	0.72	26/Jun/04 09:53:32	0.69
26/Jun/04 09:55:56	0.72	26/Jun/04 09:58:32	0.78
26/Jun/04 10:00:56	0.72	26/Jun/04 10:03:32	0.78
26/Jun/04 10:05:56	0.81	26/Jun/04 10:08:32	0.78
26/Jun/04 10:10:56	0.72	26/Jun/04 10:13:32	0.69
26/Jun/04 10:15:56	0.72	26/Jun/04 10:18:32	0.69
26/Jun/04 10:20:56	0.72	26/Jun/04 10:23:32	0.69
26/Jun/04 10:25:56	0.72	26/Jun/04 10:28:32	0.69
26/Jun/04 10:30:56	0.72	26/Jun/04 10:33:32	0.69
26/Jun/04 10:35:56	0.72	26/Jun/04 10:38:32	0.69
26/Jun/04 10:40:56	0.72	26/Jun/04 10:43:32	0.69
26/Jun/04 10:45:56	0.72	26/Jun/04 10:48:32	0.69
26/Jun/04 10:50:56	0.63	26/Jun/04 10:53:32	0.69
26/Jun/04 10:55:56	0.63	26/Jun/04 10:58:32	0.69
26/Jun/04 11:00:56	0.63	26/Jun/04 11:03:32	0.69
26/Jun/04 11:05:56	0.63	26/Jun/04 11:08:32	0.61
26/Jun/04 11:10:56	0.63	26/Jun/04 11:13:32	0.69
26/Jun/04 11:15:56	0.63	26/Jun/04 11:18:32	0.61

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**

Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	**UTM Zone**	19U
Easting	697018	**Easting**	695943
Northing	5324478	**Northing**	5323101
Date(dd-mm-yy) Time(hh:mm:ss	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 11:20:56	0.63	26/Jun/04 11:23:32	0.61
26/Jun/04 11:25:56	0.63	26/Jun/04 11:28:32	0.61
26/Jun/04 11:30:56	0.63	26/Jun/04 11:33:32	0.61
26/Jun/04 11:35:56	0.63	26/Jun/04 11:38:32	0.61
26/Jun/04 11:40:56	0.54	26/Jun/04 11:43:32	0.53
26/Jun/04 11:45:56	0.54	26/Jun/04 11:48:32	0.53
26/Jun/04 11:50:56	0.54	26/Jun/04 11:53:32	0.53
26/Jun/04 11:55:56	0.54	26/Jun/04 11:58:32	0.53
26/Jun/04 12:00:56	0.44	26/Jun/04 12:03:32	0.44
26/Jun/04 12:05:56	0.44	26/Jun/04 12:08:32	0.44
26/Jun/04 12:10:56	0.44	26/Jun/04 12:13:32	0.44
26/Jun/04 12:15:56	0.44	26/Jun/04 12:18:32	0.44
26/Jun/04 12:20:56	0.44	26/Jun/04 12:23:32	0.36
26/Jun/04 12:25:56	0.35	26/Jun/04 12:28:32	0.36
26/Jun/04 12:30:56	0.35	26/Jun/04 12:33:32	0.36
26/Jun/04 12:35:56	0.35	26/Jun/04 12:38:32	0.36
26/Jun/04 12:40:56	0.26	26/Jun/04 12:43:32	0.28
26/Jun/04 12:45:56	0.26	26/Jun/04 12:48:32	0.28
26/Jun/04 12:50:56	0.26	26/Jun/04 12:53:32	0.36
26/Jun/04 12:55:56	0.26	26/Jun/04 12:58:32	0.28
26/Jun/04 13:00:56	0.17	26/Jun/04 13:03:32	0.28
26/Jun/04 13:05:56	0.17	26/Jun/04 13:08:32	0.28
26/Jun/04 13:10:56	0.17	26/Jun/04 13:13:32	0.20
26/Jun/04 13:15:56	0.17	26/Jun/04 13:18:32	0.20
26/Jun/04 13:20:56	0.08	26/Jun/04 13:23:32	0.20
26/Jun/04 13:25:56	0.08	26/Jun/04 13:28:32	0.20
26/Jun/04 13:30:56	-0.01	26/Jun/04 13:33:32	0.20
26/Jun/04 13:35:56	-0.01	26/Jun/04 13:38:32	0.20
26/Jun/04 13:40:56	-0.01	26/Jun/04 13:43:32	0.20
26/Jun/04 13:45:56	-0.01	26/Jun/04 13:48:32	0.11
26/Jun/04 13:50:56	-0.01	26/Jun/04 13:53:32	0.11
26/Jun/04 13:55:56	-0.01	26/Jun/04 13:58:32	0.11
26/Jun/04 14:00:56	-0.01	26/Jun/04 14:03:32	0.11
26/Jun/04 14:05:56	-0.01	26/Jun/04 14:08:32	0.11
26/Jun/04 14:10:56	-0.10	26/Jun/04 14:13:32	0.11
26/Jun/04 14:15:56	-0.10	26/Jun/04 14:18:32	0.11
26/Jun/04 14:20:56	-0.10	26/Jun/04 14:23:32	0.11
26/Jun/04 14:25:56	-0.10	26/Jun/04 14:28:32	0.11
26/Jun/04 14:30:56	-0.19	26/Jun/04 14:33:32	0.03
26/Jun/04 14:35:56	-0.19	26/Jun/04 14:38:32	0.03
26/Jun/04 14:40:56	-0.19	26/Jun/04 14:43:32	0.03
26/Jun/04 14:45:56	-0.19	26/Jun/04 14:48:32	0.03
26/Jun/04 14:50:56	-0.19	26/Jun/04 14:53:32	0.03
26/Jun/04 14:55:56	-0.19	26/Jun/04 14:58:32	0.03
26/Jun/04 15:00:56	-0.19	26/Jun/04 15:03:32	-0.05
26/Jun/04 15:05:56	-0.28	26/Jun/04 15:08:32	0.03

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**

Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	UTM Zone	19U
Easting	697018	Easting	695943
Northing	5324478	Northing	5323101
Date(dd-mm-yy) Time(hh:mm:ss	Water Level Elevation (m, geodetic)	Date(dd-mm-yy) Time(hh:mm:ss)	Water Level Elevation (m, geodetic)
26/Jun/04 15:10:56	-0.28	26/Jun/04 15:13:32	-0.05
26/Jun/04 15:15:56	-0.28	26/Jun/04 15:18:32	-0.05
26/Jun/04 15:20:56	-0.28	26/Jun/04 15:23:32	-0.05
26/Jun/04 15:25:56	-0.28	26/Jun/04 15:28:32	0.03
26/Jun/04 15:30:56	-0.28	26/Jun/04 15:33:32	-0.05
26/Jun/04 15:35:56	-0.28	26/Jun/04 15:38:32	-0.05
26/Jun/04 15:40:56	-0.28	26/Jun/04 15:43:32	-0.05
26/Jun/04 15:45:56	-0.28	26/Jun/04 15:48:32	-0.05
26/Jun/04 15:50:56	-0.37	26/Jun/04 15:53:32	-0.05
26/Jun/04 15:55:56	-0.37	26/Jun/04 15:58:32	-0.05
26/Jun/04 16:00:56	-0.37	26/Jun/04 16:03:32	-0.05
26/Jun/04 16:05:56	-0.37	26/Jun/04 16:08:32	-0.05
26/Jun/04 16:10:56	-0.37	26/Jun/04 16:13:32	-0.05
26/Jun/04 16:15:56	-0.37	26/Jun/04 16:18:32	-0.05
26/Jun/04 16:20:56	-0.37	26/Jun/04 16:23:32	-0.05
26/Jun/04 16:25:56	-0.28	26/Jun/04 16:28:32	-0.05
26/Jun/04 16:30:56	-0.37	26/Jun/04 16:33:32	-0.15
26/Jun/04 16:35:56	-0.37	26/Jun/04 16:38:32	-0.05
26/Jun/04 16:40:56	-0.37	26/Jun/04 16:43:32	-0.15
26/Jun/04 16:45:56	-0.37	26/Jun/04 16:48:32	-0.05
26/Jun/04 16:50:56	-0.37	26/Jun/04 16:53:32	-0.15
26/Jun/04 16:55:56	-0.37	26/Jun/04 16:58:32	-0.15
26/Jun/04 17:00:56	-0.37	26/Jun/04 17:03:32	-0.15
26/Jun/04 17:05:56	-0.37	26/Jun/04 17:08:32	-0.15
26/Jun/04 17:10:56	-0.37	26/Jun/04 17:13:32	-0.15
26/Jun/04 17:15:56	-0.37	26/Jun/04 17:18:32	-0.15
26/Jun/04 17:20:56	-0.37	26/Jun/04 17:23:32	-0.15
26/Jun/04 17:25:56	-0.37	26/Jun/04 17:28:32	-0.15
26/Jun/04 17:30:56	-0.37	26/Jun/04 17:33:32	-0.15
26/Jun/04 17:35:56	-0.28	26/Jun/04 17:38:32	-0.15
26/Jun/04 17:40:56	-0.28	26/Jun/04 17:43:32	-0.15
26/Jun/04 17:45:56	-0.28	26/Jun/04 17:48:32	-0.15
26/Jun/04 17:50:56	-0.28	26/Jun/04 17:53:32	-0.15
26/Jun/04 17:55:56	-0.28	26/Jun/04 17:58:32	-0.15
26/Jun/04 18:00:56	-0.28	26/Jun/04 18:03:32	-0.15
26/Jun/04 18:05:56	-0.28	26/Jun/04 18:08:32	-0.15
26/Jun/04 18:10:56	-0.28	26/Jun/04 18:13:32	-0.15
26/Jun/04 18:15:56	-0.19	26/Jun/04 18:18:32	-0.15
26/Jun/04 18:20:56	-0.19	26/Jun/04 18:23:32	-0.15
26/Jun/04 18:25:56	-0.19	26/Jun/04 18:28:32	-0.15
26/Jun/04 18:30:56	-0.19	26/Jun/04 18:33:32	-0.15
26/Jun/04 18:35:56	-0.19	26/Jun/04 18:38:32	-0.15
26/Jun/04 18:40:56	-0.10	26/Jun/04 18:43:32	-0.15
26/Jun/04 18:45:56	-0.10	26/Jun/04 18:48:32	-0.15
26/Jun/04 18:50:56	-0.10	26/Jun/04 18:53:32	-0.05
26/Jun/04 18:55:56	-0.10	26/Jun/04 18:58:32	-0.05

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**

Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	**UTM Zone**	19U
Easting	697018	**Easting**	695943
Northing	5324478	**Northing**	5323101
Date(dd-mm-yy) Time(hh:mm:ss	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 19:00:56	-0.01	26/Jun/04 19:03:32	-0.05
26/Jun/04 19:05:56	-0.01	26/Jun/04 19:08:32	-0.05
26/Jun/04 19:10:56	-0.01	26/Jun/04 19:13:32	0.03
26/Jun/04 19:15:56	-0.01	26/Jun/04 19:18:32	0.03
26/Jun/04 19:20:56	0.08	26/Jun/04 19:23:32	0.03
26/Jun/04 19:25:56	0.08	26/Jun/04 19:28:32	0.03
26/Jun/04 19:30:56	0.08	26/Jun/04 19:33:32	0.11
26/Jun/04 19:35:56	0.08	26/Jun/04 19:38:32	0.11
26/Jun/04 19:40:56	0.17	26/Jun/04 19:43:32	0.11
26/Jun/04 19:45:56	0.17	26/Jun/04 19:48:32	0.20
26/Jun/04 19:50:56	0.17	26/Jun/04 19:53:32	0.20
26/Jun/04 19:55:56	0.17	26/Jun/04 19:58:32	0.20
26/Jun/04 20:00:56	0.17	26/Jun/04 20:03:32	0.20
26/Jun/04 20:05:56	0.17	26/Jun/04 20:08:32	0.28
26/Jun/04 20:10:56	0.26	26/Jun/04 20:13:32	0.28
26/Jun/04 20:15:56	0.35	26/Jun/04 20:18:32	0.28
26/Jun/04 20:20:56	0.26	26/Jun/04 20:23:32	0.28
26/Jun/04 20:25:56	0.35	26/Jun/04 20:28:32	0.28
26/Jun/04 20:30:56	0.35	26/Jun/04 20:33:32	0.36
26/Jun/04 20:35:56	0.35	26/Jun/04 20:38:32	0.36
26/Jun/04 20:40:56	0.44	26/Jun/04 20:43:32	0.36
26/Jun/04 20:45:56	0.44	26/Jun/04 20:48:32	0.44
26/Jun/04 20:50:56	0.44	26/Jun/04 20:53:32	0.36
26/Jun/04 20:55:56	0.54	26/Jun/04 20:58:32	0.44
26/Jun/04 21:00:56	0.54	26/Jun/04 21:03:32	0.44
26/Jun/04 21:05:56	0.54	26/Jun/04 21:08:32	0.53
26/Jun/04 21:10:56	0.54	26/Jun/04 21:13:32	0.53
26/Jun/04 21:15:56	0.63	26/Jun/04 21:18:32	0.53
26/Jun/04 21:20:56	0.63	26/Jun/04 21:23:32	0.61
26/Jun/04 21:25:56	0.63	26/Jun/04 21:28:32	0.61
26/Jun/04 21:30:56	0.63	26/Jun/04 21:33:32	0.61
26/Jun/04 21:35:56	0.63	26/Jun/04 21:38:32	0.69
26/Jun/04 21:40:56	0.72	26/Jun/04 21:43:32	0.69
26/Jun/04 21:45:56	0.72	26/Jun/04 21:48:32	0.69
26/Jun/04 21:50:56	0.81	26/Jun/04 21:53:32	0.69
26/Jun/04 21:55:56	0.81	26/Jun/04 21:58:32	0.69
26/Jun/04 22:00:56	0.81	26/Jun/04 22:03:32	0.69
26/Jun/04 22:05:56	0.81	26/Jun/04 22:08:32	0.78
26/Jun/04 22:10:56	0.81	26/Jun/04 22:13:32	0.78
26/Jun/04 22:15:56	0.81	26/Jun/04 22:18:32	0.86
26/Jun/04 22:20:56	0.81	26/Jun/04 22:23:32	0.86
26/Jun/04 22:25:56	0.81	26/Jun/04 22:28:32	0.86
26/Jun/04 22:30:56	0.90	26/Jun/04 22:33:32	0.86
26/Jun/04 22:35:56	0.90	26/Jun/04 22:38:32	0.94
26/Jun/04 22:40:56	0.90	26/Jun/04 22:43:32	0.94
26/Jun/04 22:45:56	0.90	26/Jun/04 22:48:32	0.94

Table B.4 **Water Level Measurements at Eel River Area for June 26, 2004 - Neap Tides**
Geodetic surveying attached to New Brunswick Grid Monument no. 22526, elevation 8.035 m

STATION	Eel Bay	STATION	Eel River Estuary
UTM Zone	19U	**UTM Zone**	19U
Easting	697018	**Easting**	695943
Northing	5324478	**Northing**	5323101
Date(dd-mm-yy) Time(hh:mm:ss	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 22:50:56	0.90	26/Jun/04 22:53:32	0.94
26/Jun/04 22:55:56	0.90	26/Jun/04 22:58:32	0.94
26/Jun/04 23:00:56	0.90	26/Jun/04 23:03:32	0.94
26/Jun/04 23:05:56	0.90	26/Jun/04 23:08:32	0.94
26/Jun/04 23:10:56	0.90	26/Jun/04 23:13:32	0.94
26/Jun/04 23:15:56	0.90	26/Jun/04 23:18:32	0.94
26/Jun/04 23:20:56	0.90	26/Jun/04 23:23:32	0.94
26/Jun/04 23:25:56	0.90	26/Jun/04 23:28:32	0.94
26/Jun/04 23:30:56	0.90	26/Jun/04 23:33:32	0.94
26/Jun/04 23:35:56	0.90	26/Jun/04 23:38:32	0.94
26/Jun/04 23:40:56	0.90	26/Jun/04 23:43:32	0.94
26/Jun/04 23:45:56	0.81	26/Jun/04 23:48:32	0.86
26/Jun/04 23:50:56	0.81	26/Jun/04 23:53:32	0.86
26/Jun/04 23:55:56	0.81	26/Jun/04 23:58:32	0.86
27/Jun/04 00:00:56	0.72		

Legend: dd-mm-yyday-month-year
hh:mm:ss hour-minute-second

Water level survey data for June 26, 2004 downstream and upstream of the dam are presented in Table B.5.

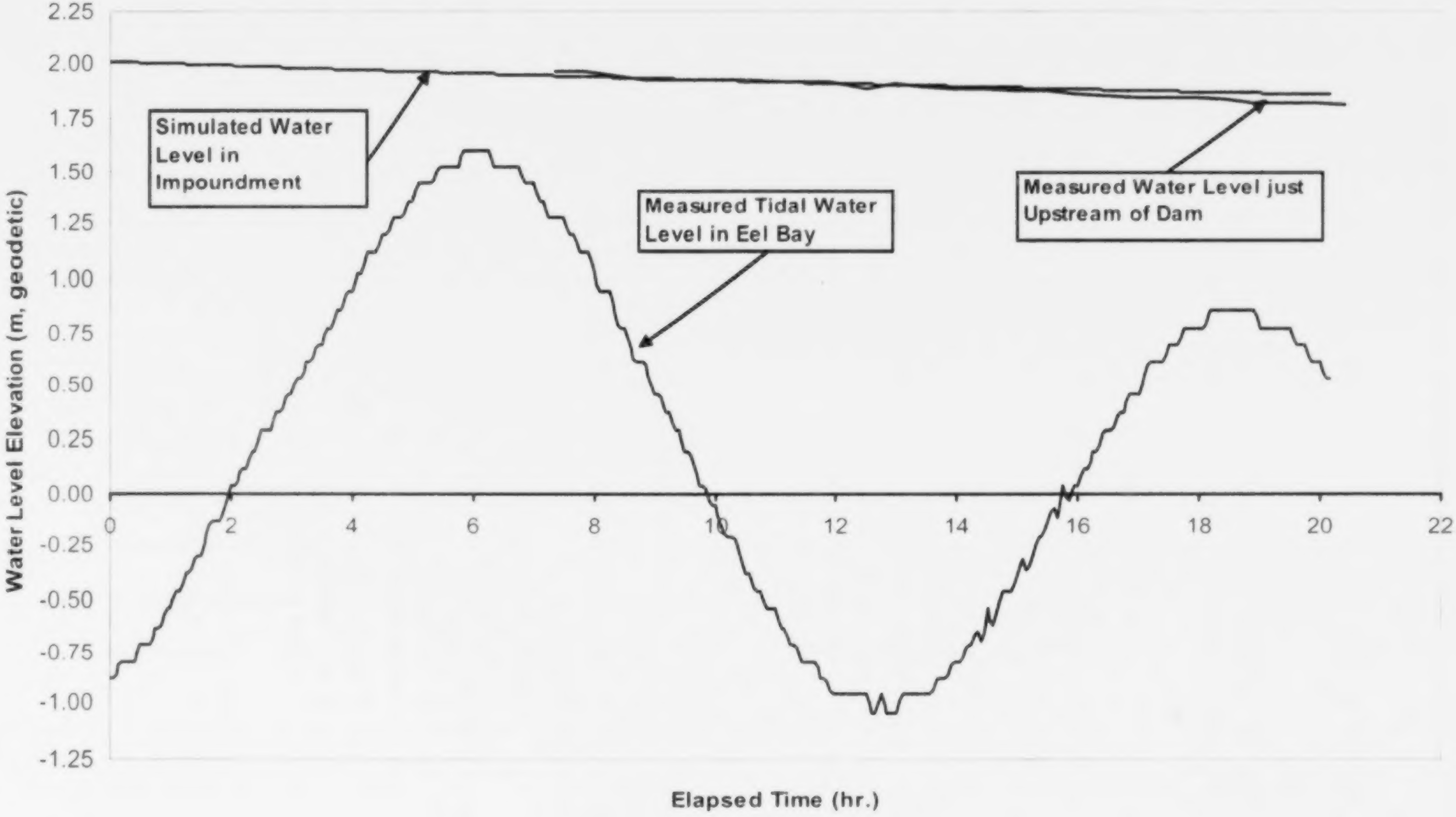
Table B.5 **Water Level Survey Data June 26, 2004**

STATION	Downstream of Dam in Estuary	STATION	Upstream of Dam in Impoundment
UTM Zone 19U		**UTM Zone 19U**	
Easting	695884	**Easting**	695697
Northing	5321763	**Northing**	5321754
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 06:48:00	0.19	26/Jun/04 09:32:00	2.06
26/Jun/04 07:30:00	0.19	26/Jun/04 10:10:00	2.06
26/Jun/04 08:20:00	0.33	26/Jun/04 10:40:00	2.06
26/Jun/04 08:37:00	0.40	26/Jun/04 11:10:00	2.06
26/Jun/04 08:57:00	0.48	26/Jun/04 11:40:00	2.06
26/Jun/04 09:36:00	0.66	26/Jun/04 12:17:00	2.06
26/Jun/04 10:06:00	0.74	26/Jun/04 12:47:00	2.06
26/Jun/04 10:35:00	0.73	26/Jun/04 13:17:00	2.06
26/Jun/04 11:06:00	0.67	26/Jun/04 13:47:00	2.04
26/Jun/04 11:36:00	0.64	26/Jun/04 14:17:00	2.04
26/Jun/04 12:06:00	0.49	26/Jun/04 14:47:00	2.04
26/Jun/04 12:37:00	0.49	26/Jun/04 15:17:00	2.04
26/Jun/04 13:07:00	0.43	26/Jun/04 15:47:00	2.05
26/Jun/04 13:37:00	0.37	26/Jun/04 16:17:00	2.04

Table B.5 Water Level Survey Data June 26, 2004

STATION	Downstream of Dam in Estuary	STATION	Upstream of Dam in Impoundment
UTM Zone 19U		**UTM Zone 19U**	
Easting	695884	**Easting**	695697
Northing	5321763	**Northing**	5321754
Date(dd-mm-yy) Time(hh:mm:ss)	**Water Level Elevation (m, geodetic)**	**Date(dd-mm-yy) Time(hh:mm:ss)**	**Water Level Elevation (m, geodetic)**
26/Jun/04 14:07:00	0.32	26/Jun/04 16:47:00	2.04
26/Jun/04 14:37:00	0.29	26/Jun/04 17:17:00	2.04
26/Jun/04 15:07:00	0.29	26/Jun/04 17:47:00	2.04
26/Jun/04 15:37:00	0.24	26/Jun/04 18:18:00	2.04
26/Jun/04 16:07:00	0.23	26/Jun/04 18:48:00	2.04
26/Jun/04 16:37:00	0.21	26/Jun/04 19:18:00	2.04
26/Jun/04 17:07:00	0.21	26/Jun/04 19:48:00	2.04
26/Jun/04 17:37:00	0.21		
26/Jun/04 18:07:00	0.21		
26/Jun/04 18:38:00	0.21		
26/Jun/04 19:08:00	0.21		
26/Jun/04 19:38:00	0.21		

Legend: dd-mm-yyday-month-year
hh:mm:ss hour-minute-second



Simulated and Observed Water Levels in the Impoundment at Eel River Dam	Date: 12/16/2005	Scale:	**Eel River Dam** ENVIRONMENTAL IMPACT ASSESSMENT Brunswick
	Job No. 15830	Figure No. **B.3**	NBDSS PROJECT No. YR101A

2.0 RATIONALE FOR THE PREDICTED FUTURE GEOMORPHOLOGICAL ENVIRONMENT

This section provides the assumptions used in developing the rationale for the geomorphological investigation.

Based on regime analyzes of estuaries and tidal inlets by Bruun and Gerritsen (1955), Leopold *et al.*, (1964), and Neill (1973), the following functional relationships have been adopted for this study:

$$Q \propto \Omega$$
$$W \propto Q^{0.72}$$
$$D \propto Q^{0.23}$$
$$A \propto Q^{0.95}$$
$$V \propto Q^{0.05}$$

Where Q is the maximum tidal discharge for the adopted tidal condition, Ω is the volume of the tidal prism below the adopted tidal elevation, W is the channel width at mid-tide, D is the channel depth, A is the cross sectional area of the channel below the adopted tidal elevation, and V is the cross sectional mean velocity. The channel geometry is taken to be a rectangular cross section of width W and depth D corresponding to the adopted high tide elevation. The area A is equal to W x D. It is accepted that the exponents for these relationships adequately describe the processes and that the ratios of the channel properties for different characteristic discharges will be in the correct order of magnitude.

Given a supply of sediment that in this case was available from the littoral drift along the coast of Eel Bay, a reduction in the tidal geometry of the tidal inlet can occur. For this situation a tidal elevation of 1.7 m (geodetic) corresponding to a large tide is adopted to estimate the existing width, depth, and area of the tidal inlet given that the original width was 90 m, the original depth was 3.5 m and the original area was 315 m^2.

The pre-dam volume of the tidal prism is taken to be the same as that for the total volume of the existing estuary below the dam and the impoundment below elevation 1.7 m, which is 3.2 million m^3. Since no detailed pre-dam surveys are available this assumption has to be adopted. Rough estimates indicate that the pre-dam volume of the tidal prism may have been in the order of 3 percent larger. The existing volume of the tidal prism is taken to be that for the estuary below the dam below elevation 1.7 m, which is 0.9 x million m^3. The predicted existing conditions and the best estimate of the existing conditions at the tidal inlet are summarized below.

Geometric Feature	Existing Condition	Predicted Existing
Width, m	30	36
Depth, m	2.7	2.6
Area, m^2	81	93

The estimates are within about 20 percent of the best estimate of the existing condition. Although the results do not match exactly, they are in the correct direction and have about the correct magnitude. The value of this analysis is to show that the reverse should be valid when the tidal prism volume is increased after removal of the dam or a portion of the dam.

Appendix C

Appendix C

Plant Species List for the Freshwater Impoundment and Saltmarsh Downstream from the Dam

Table C.1 Plant Species List for the Freshwater Impoundment

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Flowering-Rush	638	638		Butomus umbellatus	SE
Rice Cutgrass	639	639		Leersia oryzoides	S5
Least Spike-Rush	640	640		Eleocharis acicularis	S5
Corn Mint	641	641		Mentha arvensis	S5
Large Bur-Reed	642	642		Sparganium eurycarpum	S4S5
Swamp Loosestrife	643	643		Lysimachia terrestris	S5
Field Horsetail	644	644		Equisetum arvense	S5
Speckled Alder	645	645		Alnus incana	S5
Hard-Stemmed Bulrush	646	646		Schoenoplectus acutus	S4S5
Broad-Leaf Cattail	647	647		Typha latifolia	S5
Yellow Pond-Lily	648	648		Nuphar variegata	S5
Water Bulrush	649	649		Schoenoplectus subterminalis	S5
Lesser Duckweed	650	650		Lemna minor	S5
Marsh Bedstraw	651	651		Galium palustre	S5
Bulb-Bearing Water-Hemlock	652	652		Cicuta bulbifera	S5
Northern Bugleweed	653	653		Lycopus uniflorus	S5
Marsh St. John's-Wort	654	654		Triadenum fraseri	S5
Devil's Beggar-Ticks	655	655		Bidens frondosa	S5
Balsam Fir	656	656		Abies balsamea	S5
Grasses	657	657		Scirpus c Sp.	Unranked
Curly Dock	658	658		Rumex crispus	SE
Hoary Sedge	659	659		Carex canescens	S5
Hooded Skullcap	660	660		Scutellaria galericulata	S5
Tall Meadow-Rue	661	661		Thalictrum pubescens	S5
Speckled Alder	662	662		Alnus incana	S5
Spotted Joe-Pye Weed	663	663		Eupatorium maculatum	S5
Spotted Joe-Pye Weed	664	664		Eupatorium maculatum	S5
New Belgium American-Aster	665	665		Aster novi-belgii	S5
Fowl Bluegrass	666	666		Poa palustris	S5
Necklace Sedge	667	667		Carex projecta	S5
Marsh Cinquefoil	668	668		Comarum palustre	S5
Water Smartweed	669	669		Polygonum amphibium	S5
Sweet Bayberry	670	670		Myrica gale	S5
Blue-Joint Reedgrass	671	671		Calamagrostis canadensis	S5
Water Horsetail	672	672		Equisetum fluviatile	S5
Blueflag	673	673		Iris versicolor	S5
Shallow Sedge	674	674		Carex lurida	S5
Small-Fruit Bulrush	675	675		Scirpus microcarpus	S5
Water Loosestrife	676	676		Lysimachia thyrsiflora	S3S4
Broad-Leaved Water-Plantain	677	677		Alisma triviale	S5
Hemlock Water-Parsnip	678	678		Sium suave	S5
Water Dock	679	679		Rumex orbiculatus	S5
Virginia Strawberry	680	680		Fragaria virginiana	S5
Parasol White-Top	681	681		Aster umbellatus	S5
Balsam Poplar	682	682		Populus balsamifera	S5
Purple Loosestrife	683	683		Lythrum salicaria	SE

Table C.1 Plant Species List for the Freshwater Impoundment

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Flat-Top Fragrant-Golden-Rod	684	684		Euthamia graminifolia	S5
Rough-Leaved Aster	685	685		Aster radula	S5
Red Maple	686	686		Acer rubrum	S5
Silky Dogwood	687	687		Cornus sericea	S5
Smooth White Violet	688	688		Viola macloskeyi	S5
Canada Goldenrod	689	689		Solidago canadensis	S5
Narrow-Leaved Cattail	690	690		Typha angustifolia	S5
Broad-Leaf Cattail	691	691		Typha latifolia	S5
Blue Cattail	692	692		Typha x glauca	HYB
Wild Calla	693	693		Calla palustris	S5
Spotted Jewel-Weed	694	694		Impatiens capensis	S5
Small Forget-Me-Not	695	695		Myosotis laxa	S5
Smooth Rose	696	696		Rosa blanda	S5
Vetchling Peavine	697	697		Lathyrus palustris	S5
Lake-Bank Sedge	698	698		Carex lacustris	S4S5
Shining Willow	699	699		Salix lucida	S5
Hedge Bindweed	700	700		Calystegia sepium	S5
Canada Manna-Grass	701	701		Glyceria canadensis	S5
Fox Sedge	702	702		Carex vulpinoidea	S4S5
Cyperus-Like Sedge	703	703		Carex pseudocyperus	S5
Hoary Sedge	704	704		Carex canescens	S5
Marsh Willow-Herb	705	705		Epilobium palustre	S5
Brownish Sedge	706	706		Carex brunnescens	S5
Arrow-Leaved Tearthumb	707	707		Persicaria sagittata	S5
Fireweed	708	708		Epilobium angustifolium	S5
Red Raspberry	709	709		Rubus idaeus	S5
Bebb's Willow	710	710		Salix bebbiana	S5
Crested Shield-Fern	711	711		Dryopteris cristata	S5
Rough-Leaf Goldenrod	712	712		Solidago rugosa	S5
Possum-Haw Viburnum	713	713		Viburnum nudum	S5
Dwarf Red Raspberry	714	714		Rubus pubescens	S5
Creeping Butter-Cup	715	715		Ranunculus repens	SE
Rough Avens	716	716		Geum laciniatum	S5
Fringed Sedge	717	717		Carex crinita	S5
Spinulose Shield Fern	718	718		Dryopteris carthusiana	S5
Lady-Fern	719	719		Athyrium filix-femina	S5
White Turtlehead	720	720		Chelone glabra	S5
Tufted Vetch	721	721		Vicia cracca	SE
Rough Bedstraw	722	722		Galium asprellum	S5
American Mannagrass	723	723		Glyceria grandis	S5
Toad Rush	724	724		Juncus bufonius	S5
Spreading Bentgrass	725	725		Agrostis stolonifera	S5SE
Small Floating Manna-Grass	726	726		Glyceria borealis	S5
Large Water-Starwort	727	727		Callitriche heterophylla	S4S5
Ostrich Fern	728	728		Matteuccia struthiopteris	S5
American Bur-Reed	729	729		Sparganium americanum	S5

Table C.1 Plant Species List for the Freshwater Impoundment

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Low Cudweed	730	730		Gnaphalium uliginosum	SE
Wood Nettle	731	731		Laportea canadensis	S5
Large-Leaved Avens	732	732		Geum macrophyllum	S5
Field Sowthistle	733	733		Sonchus arvensis	SE
Woodland Agrimony	734	734		Agrimonia striata	S5
Black Starthistle	735	735		Centaurea nigra	SE
Stalk-Grain Sedge	736	736		Carex stipata	S5
American Bugleweed	737	737		Lycopus americanus	S5
Mad Dog Skullcap	738	738		Scutellaria lateriflora	S5
Spotted Water-Hemlock	739	739		Cicuta maculata	S5
Swamp Aster	740	740		Aster puniceus	S5
Small Purple-Fringe Orchis	741	741		Platanthera psycodes	S4
Northern White Cedar	742	742		Thuja occidentalis	S5
Interrupted Fern	743	743		Osmunda claytoniana	S5
Northern Beech Fern	744	744		Phegopteris connectilis	S5
a Hybrid Wood-fern	745	745		Dryopteris x boottii	HYB
Slender Wood Reedgrass	746	746		Cinna latifolia	S5
Marsh Blue Violet	747	747		Viola cucullata	S5
Fowl Manna-Grass	748	748		Glyceria striata	S5
Balsam Fir	749	749		Abies balsamea	S5
Canadian Yew	750	750		Taxus canadensis	S5
Bladder Sedge	751	751		Carex intumescens	S5
Black Ash	752	752		Fraxinus nigra	S5
Creeping Thistle	753	753		Cirsium arvense	SE
Cinnamon Fern	754	754		Osmunda cinnamomea	S5
Heart-Leaved Paper Birch	755	755		Betula cordifolia	S5
Retrorse Sedge	756	756		Carex retrorsa	S4
Creeping Spike-Rush	757	757		Eleocharis palustris	S5
Mountain Holly	758	758		Nemopanthus mucronatus	S5
American Mountain-Ash	759	759		Sorbus americana	S5
Paper Birch	760	760		Betula papyrifera	S5
American Larch	761	761		Larix laricina	S5
Sheep-Laurel	762	762		Kalmia angustifolia	S5
New York Fern	763	763		Thelypteris noveboracensis	S5
Woodland Horsetail	764	764		Equisetum sylvaticum	S5
Wild Sarsaparilla	765	765		Aralia nudicaulis	S5
Stiff Clubmoss	766	766		Lycopodium annotinum	S5
Dwarf Dogwood	767	767		Cornus canadensis	S5
Quaking Aspen	768	768		Populus tremuloides	S5
Black Holly	769	769		Ilex verticillata	S5
Marsh Fern	770	770		Thelypteris palustris	S5
Rough Bentgrass	771	771		Agrostis scabra	S5
Yellow Sedge	772	772		Carex flava	S5
Tartarian Honeysuckle	773	773		Lonicera tatarica	SE
Serviceberry	774	774		Amelanchier x neglecta Sp.	Unranked
Lesser Panicled Sedge	775	775		Carex diandra	S3

Table C.1 Plant Species List for the Freshwater Impoundment

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Bear Sedge	776	776		Carex utriculata	S5
Watercress	777	777		Rorippa microphylla	SE
Northeastern White Water-Crowfoot	778	778		Ranunculus trichophyllus	S4S5
Hairy Willow-Herb	779	779		Epilobium ciliatum	S5
Hooded Ladies'-Tresses	780	780		Spiranthes romanzoffiana	S4
Water Smartweed	781	781		Polygonum amphibium	S5
Small Bedstraw	782	782		Galium trifidum	S5
Broadleaf Arrowhead	783	783		Sagittaria latifolia	S5
Clasping-Leaf Pondweed	784	784		Potamogeton perfoliatus	S4S5
Bristly Crowfoot	785	785		Ranunculus pensylvanicus	S4
Vernal Water Starwort	786	786		Callitriche palustris	S5
Meadow Foxtail	787	787		Alopecurus pratensis	SE
Blunt Spike-Rush	788	788		Eleocharis obtusa	S5
Creeping Spike-Rush	789	789		Eleocharis palustris	S5
Leafy Pondweed	790	790		Potamogeton foliosus	S4
White Avens	791	791		Geum canadense	S5
Bog Yellow-Cress	792	792		Rorippa palustris	S5
Northern Pondweed	793	793		Potamogeton alpinus	S5
Canada Anemone	794	794		Anemone canadensis	S5
Broad-Leaved Water-Plantain	795	795		Alisma triviale	S5
Marshpepper Smartweed	796	796		Persicaria hydropiper	S5SE
Linear-Leaved Willow-Herb	797	797		Epilobium leptophyllum	S5
Water-Milfoil	798	798		Myriophyllum species	n/a
Water Sedge	799	799		Carex aquatilis	S4S5
Marsh Horsetail	800	800		Equisetum palustre	S3
Broad Waterweed	801	801		Elodea canadensis	S4S5
Heart-Leaved Willow	802	802		Salix eriocephala	S5
Floating Pondweed	803	803		Potamogeton natans	S5
Meadow Willow	804	804		Salix petiolaris	S5
Slender Pondweed	805	805		Potamogeton pusillus	S5
Greater Bladder-Wort	806	806		Utricularia macrorhiza	S5
Pussy Willow	807	807		Salix discolor	S5
Marsh Marigold	808	808		Caltha palustris	S4S5
Grassleaf Arrowhead	809	809		Sagittaria graminea	S4
Mountain Maple	810	810		Acer spicatum	S5
Guelder-Rose Viburnum	811	811		Viburnum opulus	S5
Square-Stem Monkeyflower	812	812		Mimulus ringens	S4S5
Silver Maple	813	813		Acer saccharinum	S4S5
Nodding Beggar-Ticks	814	814		Bidens cernua	S5
Cow Parsnip	815	815		Heracleum maximum	S5
Smooth Gooseberry	816	816		Ribes hirtellum	S5
Fresh Water Cordgrass	817	817		Spartina pectinata	S5
Leatherleaf	818	818		Chamaedaphne calyculata	S5
Common Water-Flaxseed	849	849		Spirodela polyrrhiza	S2
Northern Bayberry	850	850		Myrica pensylvanica	S5
Lady's Thumb	851	851		Persicaria maculosa	SE

Table C.1 Plant Species List for the Freshwater Impoundment

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Cursed Crowfoot	852	852		Ranunculus sceleratus	S1
Swamp Red Currant	853	853		Ribes triste	S5
Salt-Marsh Sedge	854	854		Carex recta	S2
Slim-Stem Small-Reedgrass	855	855		Calamagrostis stricta	S4?
Yellow Rocket	856	856		Barbarea vulgaris	SE
Small Bedstraw	857	857		Galium trifidum	S5
Bebb's Sedge	858	858		Carex bebbii	S4?

Legend: ? inexact or uncertain by AC CDC

Jacques
Whitford

Table C.2 Plant Species List for the Saltmarsh Downstream from the Dam

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Saltwater Cordgrass	819	819		*Spartina alterniflora*	S5
Salt-Meadow Cordgrass	820	820		*Spartina patens*	S5
Fresh Water Cordgrass	821	821		*Spartina pectinata*	S5
Fox-Tail Barley	822	822		*Hordeum jubatum*	S5
Three-Square Bulrush	823	823		*Schoenoplectus pungens*	S5
Seaside Goldenrod	824	824		*Solidago sempervirens*	S5
Sea Milkwort	825	825		*Glaux maritima*	S5
Silverweed	826	826		*Argentina anserina*	S5
Black-Grass Rush	827	827		*Juncus gerardii*	S5
Seaside Crowfoot	828	828		*Ranunculus cymbalaria*	S4
Seaside Plantain	829	829		*Plantago maritima*	S5
Common Bog Arrow-Grass	830	830		*Triglochin maritima*	S5
Scot's Lovage	831	831		*Ligusticum scoticum*	S5
Red Fescue	832	832		*Festuca rubra*	S5
Quackgrass	833	833		*Elytrigia repens*	SE
Hedge Bindweed	834	834		*Calystegia sepium*	S5
Field Sowthistle	835	835		*Sonchus arvensis*	SE
Baltic Rush	836	836		*Juncus arcticus*	S5
American Sea-Rocket	837	837		*Cakile edentula*	S5
New Belgium American-Aster	838	838		*Aster novi-belgii*	S5
Hard-Stemmed Bulrush	839	839		*Schoenoplectus acutus*	S4S5
Spreading Bentgrass	840	840		*Agrostis stolonifera*	S5SE
Chaffy Sedge	841	841		*Carex paleacea*	S5
Jointed Glasswort	842	842		*Salicornia europaea*	S5
False Mayweed	843	843		*Matricaria maritima*	SE
Broad-Leaf Cattail	844	844		*Typha latifolia*	S5
Salt-Marsh Spike-Rush	845	845		*Eleocharis halophila*	S4?
Maritime Sea-blite	846	846		*Suaeda maritima*	S5
Narrow-Leaved Cattail	847	847		*Typha angustifolia*	S5
Sea-Lavender	848	848		*Limonium carolinianum*	S5
Three-Square Bulrush	859	859		Schoenoplectus pungens	S5
	860	860		*atriplex Sp.*	

Table C.2 Plant Species List for the Saltmarsh Downstream from the Dam

Common Plant Name	Key	Key/#agg	Plant Note	Scientific Plant Name	SRANK
Ditch-Grass	861	861		*Ruppia maritima*	S5
Creeping Alkali Grass	862	862		*Puccinellia pumila*	S4S5
Old-Man-In-The-Spring	863	863		*Senecio vulgaris*	SE

Legend: ? inexact or uncertain by AC CDC

Appendix D

Appendix D

Cross Section and Sediment Information

Jacques
Whitford

Jacques
Whitford

Sample Point	Sample Date	Sample Local Time (ADT)	Surveyed UTM Coordinate X (m)	Surveyed UTM Coordinate Y (m)	Projected UTM Coordinate X (m)	Projected UTM Coordinate Y (m)	Measured Water Depth at Time of Survey (m)	Geodetic Water Surface Elevation (m)	Geodetic Bottom Elevation (m)	Projected Distance from Left Bank (m)	Substrate Type	Comments
CROSS SECTION 1												
1A	21-Jun-04	14:23	692561	5321748	692561	5321748	0.000	1.950	1.950	0.0	shore	
1B	21-Jun-04	14:24	692561	5321750	692560	5321748	0.650	1.950	1.300	0.3	hardpack fines	
1C	21-Jun-04	14:26	692561	5321749	692561	5321748	1.020	1.950	0.930	0.6	hardpack fines	
1D	21-Jun-04	14:27	692568	5321748	692568	5321747	2.010	1.950	-0.060	7.2	soft fines	30 cm penetration
1E	21-Jun-04	14:27	692569	5321748	692569	5321747	2.300	1.950	-0.350	8.3	soft fines	30 cm penetration
1F	21-Jun-04	14:28	692574	5321751	692574	5321747	1.950	1.950	0.000	13.2	soft fines	30 cm penetration
1G	21-Jun-04	14:29	692584	5321749	692584	5321746	1.880	1.950	0.070	23.4	soft fines	30 cm penetration
1H	21-Jun-04	14:30	692596	5321747	692596	5321745	2.200	1.950	-0.250	35.2	soft fines	30 cm penetration
1I	21-Jun-04	14:31	692600	5321745	692600	5321744	1.200	1.950	0.750	39.8	soft fines	30 cm penetration
1J	21-Jun-04	14:32	692605	5321745	692605	5321744	0.540	1.950	1.410	44.3	soft fines	30 cm penetration
1K	21-Jun-04	14:32	692607	5321744	692607	5321744	0.000	1.950	1.950	46.8	shore	
CROSS SECTION 2												
2A	21-Jun-04	15:55	692969	5322123	692969	5322123	0.430	1.950	1.520	0.0	swampy area, matted organic bottom	Swampy Area. Unable to reach north shore due to swampy conditions
2B	21-Jun-04	15:57	692972	5322108	692974	5322109	0.200	1.950	1.750	15.1	swampy area, matted organic bottom	
2C	21-Jun-04	16:02	692984	5322087	692983	5322087	0.390	1.950	1.560	39.1	swampy area, matted organic bottom	
2D	21-Jun-04	16:03	692985	5322083	692984	5322083	0.000	1.950	1.950	43.2	shore, island	island
2E	21-Jun-04	16:09	692984	5322072	692988	5322074	0.000	1.950	1.950	53.4	shore, island	island
2F	21-Jun-04	16:10	692988	5322066	692991	5322067	0.510	1.950	1.440	60.4	sandy	20 cm penetration
2G	21-Jun-04	16:11	692989	5322065	692991	5322066	1.000	1.950	0.950	61.9	soft fines	30 cm penetration
2H	21-Jun-04	16:14	693006	5322042	693002	5322040	1.600	1.950	0.350	89.8	soft fines	30 cm penetration
2I	21-Jun-04	16:14	693008	5322032	693005	5322031	2.000	1.950	-0.050	99.2	sandy gravel	
2J	21-Jun-04	16:15	693015	5322020	693010	5322018	2.400	1.950	-0.450	112.9	sandy gravel	
2K	21-Jun-04	16:17	693017	5322015	693012	5322013	1.600	1.950	0.350	118.4	sandy gravel	
2L	21-Jun-04	16:18	693017	5322010	693014	5322009	0.850	1.950	1.100	122.9	sandy gravel	
2M	21-Jun-04	16:19	693015	5322005	693015	5322005	0.000	1.950	1.950	126.8	shore, soft fines	
CROSS SECTION 3												
3A	21-Jun-04	16:43	693199	5322271	693199	5322271	0.000	1.950	1.950	0.0	shore	
3B	21-Jun-04	16:44	693198	5322268	693199	5322271	0.600	1.950	1.350	0.4	soft fines	30 cm penetration
3C	21-Jun-04	16:46	693217	5322246	693224	5322259	0.850	1.950	1.100	28.0	soft fines	30 cm penetration
3D	21-Jun-04	16:47	693272	5322215	693280	5322231	1.400	1.950	0.550	90.5	soft fines	30 cm penetration
3E	21-Jun-04	16:48	693342	5322187	693347	5322197	1.650	1.950	0.300	165.9	soft fines	30 cm penetration
3F	21-Jun-04	16:49	693366	5322180	693369	5322186	1.950	1.950	0.000	190.3	soft fines	30 cm penetration
3G	21-Jun-04	16:50	693403	5322162	693406	5322167	1.400	1.950	0.550	231.4	soft fines	30 cm penetration
3H	21-Jun-04	16:50	693435	5322144	693439	5322151	0.800	1.950	1.150	268.6	soft fines	30 cm penetration
3I	21-Jun-04	16:52	693506	5322111	693508	5322116	0.600	1.950	1.350	346.2	soft fines	30 cm penetration
3J	21-Jun-04	16:52	693522	5322104	693524	5322108	0.400	1.950	1.550	363.7	soft fines	vegetation
3K	21-Jun-04	16:53	693549	5322095	693549	5322095	0.000	1.950	1.950	392.1	shore	
CROSS SECTION 4												
4A	21-Jun-04	17:10	693697	5322629	693697	5322629	0.500	1.950	1.450	0.0	soft fines	30 cm penetration, swampy area, vegetation. Unable to reach north shore due to swampy conditions
4B	21-Jun-04	17:12	693705	5322608	693708	5322609	0.800	1.950	1.150	22.9	soft fines	30 cm penetration, swampy area, vegetation
4C	21-Jun-04	17:14	693723	5322601	693715	5322597	1.400	1.950	0.550	37.5	soft fines	30 cm penetration
4D	21-Jun-04	17:15	693757	5322532	693751	5322530	1.600	1.950	0.350	114.0	soft fines	30 cm penetration
4E	21-Jun-04	17:17	693782	5322486	693777	5322483	1.300	1.950	0.650	166.9	soft fines	30 cm penetration
4F	21-Jun-04	17:19	693834	5322386	693831	5322384	1.900	1.950	0.050	279.8	soft fines	30 cm penetration
4G	21-Jun-04	17:20	693852	5322352	693850	5322351	1.300	1.950	0.650	317.7	soft fines	30 cm penetration
4H	21-Jun-04	17:21	693870	5322320	693867	5322319	1.500	1.950	0.450	354.4	soft fines	30 cm penetration
4I	21-Jun-04	17:23	693870	5322312	693871	5322313	1.200	1.950	0.750	361.5	soft fines	30 cm penetration
4J	21-Jun-04	17:24	693874	5322307	693874	5322307	0.000	1.950	1.950	367.7	shore	

Sample Point	Sample Date	Sample Local Time (ADT)	Surveyed UTM Coordinate X (m)	Surveyed UTM Coordinate Y (m)	Projected UTM Coordinate X (m)	Projected UTM Coordinate Y (m)	Measured Water Depth at Time of Survey (m)	Geodetic Water Surface Elevation (m)	Geodetic Bottom Elevation (m)	Projected Distance from Left Bank (m)	Substrate Type	Comments
CROSS SECTION 5												
5A	21-Jun-04	17:43	694111	5322828	694111	5322828	0.000	1.950	1.950	0.0	shore	Grassy
5B	21-Jun-04	17:43	694115	5322822	694115	5322822	0.400	1.950	1.550	6.8	fines	Matted vegetation
5C	21-Jun-04	17:44	694119	5322816	694119	5322816	0.900	1.950	1.050	14.2	fines	Matted vegetation
5D	21-Jun-04	17:45	694128	5322797	694131	5322799	1.400	1.950	0.550	34.8	soft fines	30 cm penetration
5E	21-Jun-04	17:46	694150	5322765	694152	5322767	1.800	1.950	0.150	73.2	soft fines	30 cm penetration
5F	21-Jun-04	17:48	694197	5322703	694196	5322702	1.450	1.950	0.500	151.5	soft fines	30 cm penetration
5G	21-Jun-04	17:50	694258	5322625	694252	5322620	1.500	1.950	0.450	250.3	soft fines	30 cm penetration
5H	21-Jun-04	17:51	694281	5322600	694270	5322593	1.900	1.950	0.050	284.0	soft fines	30 cm penetration
5I	21-Jun-04	17:52	694317	5322525	694317	5322524	1.300	1.950	0.650	366.7	soft fines	30 cm penetration
5J	21-Jun-04	17:53	694329	5322510	694327	5322509	1.000	1.950	0.950	385.3	fines	Matted vegetation
5K	21-Jun-04	17:54	694341	5322490	694340	5322490	0.700	1.950	1.250	408.3	fines	Matted vegetation
5L	21-Jun-04	17:56	694416	5322372	694418	5322374	0.750	1.950	1.200	548.0	fines	Matted vegetation
5M	21-Jun-04	17:57	694427	5322361	694427	5322361	0.000	1.950	1.950	563.3	shore	Swamp
CROSS SECTION 6												
6A	22-Jun-04	14:36	694762	5323071	694762	5323071	0.000	1.950	1.950	0.0	shore, sand, gravel	
6B	22-Jun-04	14:36	694764	5323068	694762	5323069	0.500	1.950	1.450	2.2	sand, gravel	
6C	22-Jun-04	14:37	694764	5323067	694762	5323067	1.020	1.950	0.930	3.4	sand, gravel	
6D	22-Jun-04	14:39	694764	5323064	694762	5323064	1.350	1.950	0.600	7.0	soft fines	30 cm penetration
6E	22-Jun-04	14:40	694759	5323046	694761	5323046	1.600	1.950	0.350	24.7	soft fines	30 cm penetration
6F	22-Jun-04	14:41	694751	5323002	694758	5323002	1.800	1.950	0.150	69.0	soft fines	30 cm penetration
6G	22-Jun-04	14:43	694756	5322949	694754	5322949	1.900	1.950	0.050	122.2	soft fines	30 cm penetration
6H	22-Jun-04	14:45	694748	5322866	694749	5322866	1.900	1.950	0.050	205.1	soft fines	30 cm penetration
6I	22-Jun-04	14:46	694745	5322800	694744	5322800	1.350	1.950	0.600	271.5	soft fines	30 cm penetration
6J	22-Jun-04	14:47	694746	5322771	694742	5322771	1.000	1.950	0.950	300.6	soft fines	Matted vegetation
6K	22-Jun-04	14:48	694744	5322766	694742	5322767	0.660	1.950	1.290	304.9	soft fines	Matted vegetation
6L	22-Jun-04	14:49	694743	5322763	694742	5322763	0.360	1.950	1.590	308.6	soft fines	Matted vegetation
6M	22-Jun-04	14:50	694741	5322756	694741	5322756	0.000	1.950	1.950	315.4	shore	
CROSS SECTION 6B												
6B-A	30-Jun-04	14:19	695166	5323048	695166	5323048	0.000	1.940	1.940	0.0	shore	
6B-B	30-Jun-04	14:20	695161	5323042	695160	5323043	0.380	1.940	1.560	7.8	silt	vegetation
6B-C	30-Jun-04	14:21	695161	5323039	695159	5323041	0.580	1.940	1.360	10.1	silt	vegetation
6B-D	30-Jun-04	14:22	695159	5323035	695156	5323039	0.880	1.940	1.060	13.6	silt	vegetation
6B-E	30-Jun-04	14:24	695156	5323029	695151	5323034	1.220	1.940	0.720	20.3	silty bottom	
6B-F	30-Jun-04	14:26	695106	5322985	695102	5322989	1.650	1.940	0.290	86.7	silty bottom	
6B-G	30-Jun-04	14:27	695087	5322957	695078	5322967	1.740	1.940	0.200	119.7	silty bottom	
6B-H	30-Jun-04	14:29	695014	5322896	695008	5322903	1.820	1.940	0.120	214.9	silty bottom	
6B-I	30-Jun-04	14:31	694929	5322825	694926	5322828	1.900	1.940	0.040	325.5	silty bottom	
6B-J	30-Jun-04	14:33	694847	5322754	694847	5322755	1.780	1.940	0.160	433.4	silty bottom	
6B-K	30-Jun-04	14:34	694815	5322728	694817	5322727	1.300	1.940	0.640	474.6	silty bottom	
6B-L	30-Jun-04	14:35	694812	5322725	694813	5322724	0.750	1.940	1.190	479.0	silt	vegetation
6B-M	30-Jun-04	14:35	694810	5322722	694811	5322722	0.270	1.940	1.670	482.5	silt	vegetation
6B-N	30-Jun-04	14:36	694809	5322720	694809	5322720	0.000	1.940	1.940	485.5	shore	

Sample Point	Sample Date	Sample Local Time (ADT)	Surveyed UTM Coordinate X (m)	Surveyed UTM Coordinate Y (m)	Projected UTM Coordinate X (m)	Projected UTM Coordinate Y (m)	Measured Water Depth at Time of Survey (m)	Geodetic Water Surface Elevation (m)	Geodetic Bottom Elevation (m)	Projected Distance from Left Bank (m)	Substrate Type	Comments
CROSS SECTION 7												
7A	22-Jun-04	15:00	695233	5322697	695233	5322697	0.000	1.950	1.950	0.0	shore	Swampy
7B	22-Jun-04	15:00	695228	5322698	695228	5322696	0.250	1.950	1.700	4.9	soft fines	Matted vegetation
7C	22-Jun-04	15:01	695223	5322697	695224	5322695	0.730	1.950	1.220	9.8	soft fines	Matted vegetation
7D	22-Jun-04	15:02	695220	5322698	695221	5322695	1.020	1.950	0.930	12.7	soft fines	Matted vegetation
7E	22-Jun-04	15:03	695212	5322697	695213	5322693	1.350	1.950	0.600	20.7	soft fines	30 cm penetration
7F	22-Jun-04	15:04	695195	5322694	695196	5322690	1.700	1.950	0.250	37.8	soft fines	30 cm penetration
7G	22-Jun-04	15:06	695068	5322670	695069	5322664	1.820	1.950	0.130	167.7	soft fines	30 cm penetration
7H	22-Jun-04	15:08	694991	5322651	694992	5322648	1.880	1.950	0.070	246.6	soft fines	30 cm penetration
7I	22-Jun-04	15:09	694915	5322631	694915	5322633	1.850	1.950	0.100	325.2	soft fines	30 cm penetration
7J	22-Jun-04	15:11	694862	5322619	694861	5322622	1.650	1.950	0.300	379.8	soft fines	30 cm penetration
7K	22-Jun-04	15:11	694858	5322617	694858	5322621	1.100	1.950	0.850	383.3	soft fines	30 cm penetration
7L	22-Jun-04	15:12	694855	5322618	694855	5322621	0.650	1.950	1.300	386.2	soft fines	Matted vegetation
7M	22-Jun-04	15:13	694851	5322618	694851	5322620	0.380	1.950	1.570	390.2	soft fines	Matted vegetation
7N	22-Jun-04	15:13	694846	5322619	694846	5322619	0.000	1.950	1.950	394.7	soft fines	Matted vegetation, shore not well-defined
CROSS SECTION 8												
8A	22-Jun-04	15:29	695220	5322665	695220	5322665	0.000	1.950	1.950	0.0	shore	Swampy
8B	22-Jun-04	15:30	695213	5322656	695215	5322655	0.390	1.950	1.560	10.6	soft fines	Matted vegetation
8C	22-Jun-04	15:31	695210	5322648	695211	5322648	0.660	1.950	1.290	19.3	soft fines	Matted vegetation
8D	22-Jun-04	15:33	695205	5322655	695213	5322652	1.150	1.950	0.800	15.0	soft fines	Matted vegetation
8E	22-Jun-04	15:34	695200	5322644	695207	5322640	1.600	1.950	0.350	27.6	soft fines	30 cm penetration
8F	22-Jun-04	15:35	695182	5322614	695191	5322609	1.850	1.950	0.100	62.8	soft fines	30 cm penetration
8G	22-Jun-04	15:37	695103	5322483	695122	5322473	1.950	1.950	0.000	215.5	soft fines	30 cm penetration
8H	22-Jun-04	15:40	695024	5322369	695060	5322351	1.950	1.950	0.000	352.2	soft fines	30 cm penetration
8I	22-Jun-04	15:43	694915	5322197	694968	5322170	1.900	1.950	0.050	555.0	soft fines	30 cm penetration
8J	22-Jun-04	15:46	694858	5321997	694875	5321988	1.800	1.950	0.150	759.6	soft fines	30 cm penetration
8K	22-Jun-04	15:47	694855	5321966	694862	5321962	1.300	1.950	0.650	788.7	soft fines	30 cm penetration
8L	22-Jun-04	15:48	694854	5321945	694853	5321945	1.050	1.950	0.900	807.9	soft fines	Matted vegetation
8M	22-Jun-04	15:50	694848	5321932	694847	5321933	0.460	1.950	1.490	821.5	soft fines	Matted vegetation
8N	22-Jun-04	15:50	694846	5321930	694846	5321930	0.180	1.950	1.770	824.7	hardpack fines	vegetation
8O	22-Jun-04	15:51	694845	5321928	694845	5321928	0.000	1.950	1.950	826.9	shore	
CROSS SECTION 9												
9A	22-Jun-04	16:08	695487	5322342	695487	5322342	0.000	1.950	1.950	0.0	shore	Swampy
9B	22-Jun-04	16:08	695488	5322340	695488	5322340	0.700	1.950	1.250	1.3	soft fines	20 cm penetration
9C	22-Jun-04	16:10	695493	5322331	695490	5322330	1.320	1.950	0.630	11.6	soft fines	30 cm penetration
9D	22-Jun-04	16:11	695492	5322323	695492	5322323	1.900	1.950	0.050	19.5	soft fines	30 cm penetration
9E	22-Jun-04	16:13	695483	5322239	695513	5322248	2.050	1.950	-0.100	97.4	soft fines	30 cm penetration
9F	22-Jun-04	16:16	695544	5322085	695556	5322089	1.980	1.950	-0.030	262.3	soft fines	30 cm penetration
9G	22-Jun-04	16:19	695596	5321938	695597	5321939	2.000	1.950	-0.050	417.7	soft fines	30 cm penetration
9H	22-Jun-04	16:21	695622	5321850	695621	5321850	1.990	1.950	-0.040	509.7	soft fines	30 cm penetration
9I	22-Jun-04	16:23	695641	5321786	695639	5321785	2.000	1.950	-0.050	576.7	soft fines	30 cm penetration
9J	22-Jun-04	16:26	695644	5321763	695645	5321763	1.340	1.950	0.610	599.9	rubble, gravel, hardpack	
9K	22-Jun-04	16:26	695647	5321760	695646	5321760	0.660	1.950	1.290	602.8	rubble, gravel, hardpack	
9L	22-Jun-04	16:27	695647	5321757	695647	5321757	0.350	1.950	1.600	605.7	rubble, gravel, hardpack	
9M	22-Jun-04	16:27	695647	5321755	695647	5321755	0.000	1.950	1.950	608.1	shore	

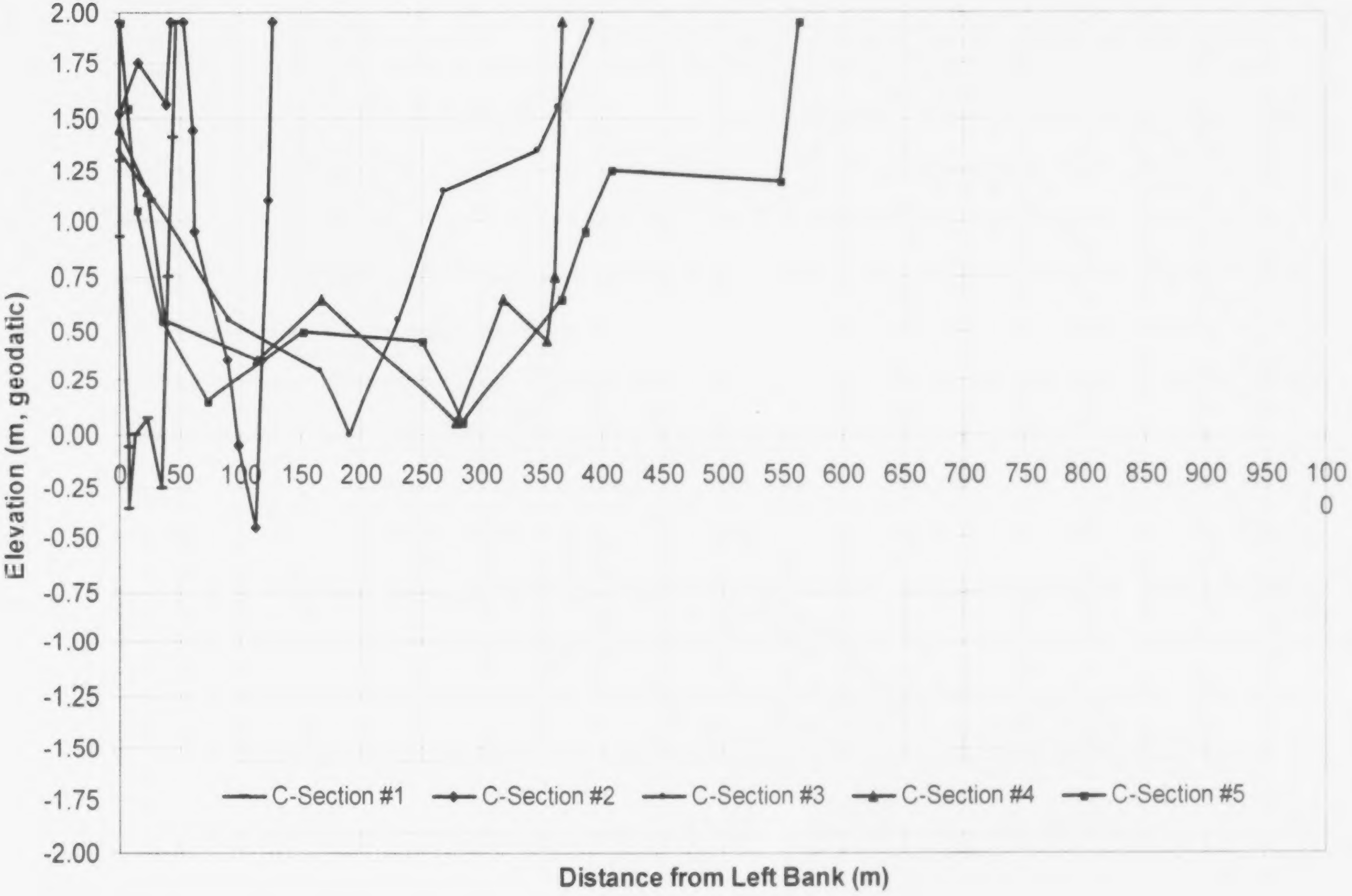
Sample Point	Sample Date	Sample Local Time (ADT)	Surveyed UTM Coordinate X (m)	Surveyed UTM Coordinate Y (m)	Projected UTM Coordinate X (m)	Projected UTM Coordinate Y (m)	Measured Water Depth at Time of Survey (m)	Geodetic Water Surface Elevation (m)	Geodetic Bottom Elevation (m)	Projected Distance from Left Bank (m)	Substrate Type	Comments
CROSS SECTION 10												
10A	22-Jun-04	7:41	695716	5321992	695716	5321992	0.000	1.260	1.260	0.0	shore, boulder, rubble, cobble, gravel	
10B	22-Jun-04	7:42	695719	5321990	695718	5321989	0.780	1.260	0.480	3.6	boulder, rubble, cobble, gravel	
10C	22-Jun-04	7:44	695722	5321994	695717	5321991	1.500	1.260	-0.240	1.6	soft fines	10 cm penetration
10D	22-Jun-04	7:46	695771	5321927	695768	5321925	1.300	1.260	-0.040	84.6	soft fines	30 cm penetration
10E	22-Jun-04	7:47	695826	5321861	695822	5321857	1.100	1.260	0.160	171.2	sand, gravel	
10F	22-Jun-04	7:49	695857	5321825	695851	5321820	0.900	1.260	0.360	218.8	sand, gravel	
10G	22-Jun-04	7:50	695868	5321804	695866	5321802	1.100	1.260	0.160	242.2	sand, gravel	
10H	22-Jun-04	7:51	695885	5321780	695884	5321779	1.550	1.260	-0.290	270.9	sand, gravel	
10I	22-Jun-04	7:51	695896	5321768	695894	5321766	1.000	1.260	0.260	287.4	sand, gravel	
10J	22-Jun-04	7:53	695899	5321761	695899	5321760	0.740	1.260	0.520	295.3	sand, gravel	
10K	22-Jun-04	7:53	695903	5321757	695902	5321756	0.460	1.260	0.800	300.8	sand, gravel	
10L	22-Jun-04	7:54	695906	5321751	695906	5321751	0.000	1.260	1.260	307.3	shore	
CROSS SECTION 11												
11A	22-Jun-04	8:20	695738	5321855	695738	5321855	0.000	1.143	1.143	0.0	shore, boulder, rubble, cobble, gravel	
11B	22-Jun-04	8:21	695740	5321856	695740	5321856	0.780	1.143	0.363	1.7	boulder, rubble, cobble, gravel	
11C	22-Jun-04	8:22	695742	5321857	695742	5321857	1.040	1.143	0.103	4.1	sand, gravel	
11D	22-Jun-04	8:23	695757	5321864	695756	5321865	1.600	1.143	-0.457	20.2	sand, silt, some gravel	10 cm penetration
11E	22-Jun-04	8:24	695774	5321871	695772	5321875	1.100	1.143	0.043	38.9	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
11F	22-Jun-04	8:26	695857	5321910	695851	5321921	1.200	1.143	-0.057	130.2	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
11G	22-Jun-04	8:30	696064	5322042	696063	5322043	1.190	1.143	-0.047	374.9	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
11H	22-Jun-04	8:33	696241	5322149	696242	5322147	1.150	1.143	-0.007	581.9	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
11I	22-Jun-04	8:34	696253	5322156	696255	5322154	0.720	1.143	0.423	596.3	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
11J	22-Jun-04	8:34	696257	5322157	696258	5322156	0.380	1.143	0.763	599.8	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
11K	22-Jun-04	8:35	696259	5322157	696259	5322157	0.000	1.143	1.143	601.6	shore	
CROSS SECTION 12												
12A	22-Jun-04	8:48	695673	5322226	695673	5322226	0.000	1.003	1.003	0.0	shore, boulder, rubble, cobble, gravel	
12B	22-Jun-04	8:49	695676	5322224	695676	5322226	0.650	1.003	0.353	3.4	rubble, gravel, gravel	
12C	22-Jun-04	8:50	695678	5322226	695678	5322226	0.990	1.003	0.013	5.2	sand, silt, some gravel	20 cm penetration
12D	22-Jun-04	8:52	695693	5322226	695693	5322224	1.150	1.003	-0.147	20.3	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
12E	22-Jun-04	8:54	695842	5322212	695842	5322208	1.020	1.003	-0.017	170.4	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
12F	22-Jun-04	8:57	695992	5322200	695991	5322191	1.050	1.003	-0.047	320.2	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
12G	22-Jun-04	8:59	696089	5322189	696088	5322181	1.000	1.003	0.003	418.0	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
12H	22-Jun-04	9:00	696176	5322176	696175	5322171	0.920	1.003	0.083	505.4	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
12I	22-Jun-04	9:03	696249	5322164	696249	5322163	0.840	1.003	0.163	580.0	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
12J	22-Jun-04	9:03	696252	5322163	696252	5322162	0.510	1.003	0.493	583.4	sand, gravel	
12K	22-Jun-04	9:04	696257	5322162	696257	5322162	0.000	1.003	1.003	588.3	shore	

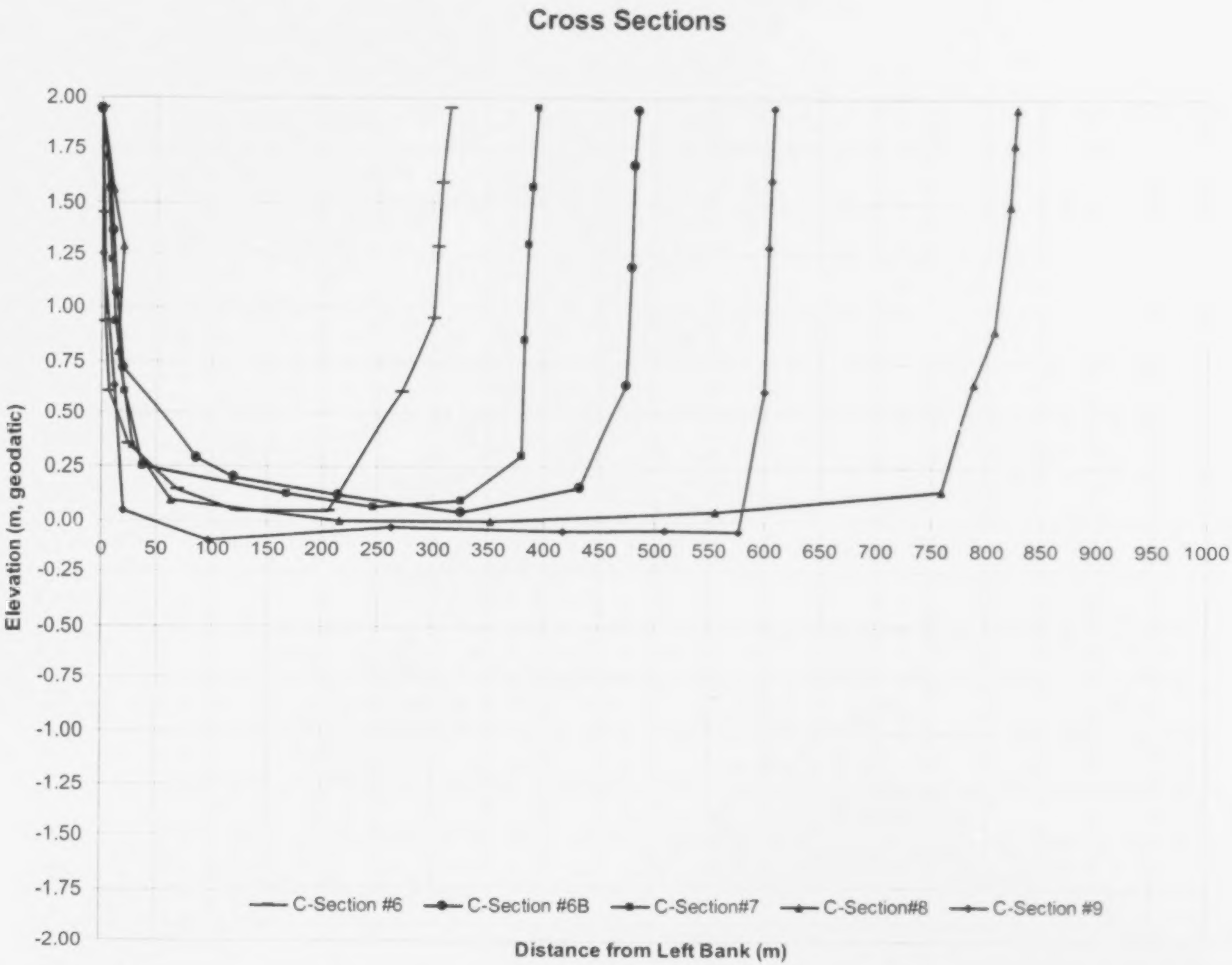
Sample Point	Sample Date	Sample Local Time (ADT)	Surveyed UTM Coordinate X (m)	Surveyed UTM Coordinate Y (m)	Projected UTM Coordinate X (m)	Projected UTM Coordinate Y (m)	Measured Water Depth at Time of Survey (m)	Geodetic Water Surface Elevation (m)	Geodetic Bottom Elevation (m)	Projected Distance from Left Bank (m)	Substrate Type	Comments
CROSS SECTION 13												
13A	22-Jun-04	9:18	695633	5322291	695633	5322291	0.000	0.852	0.852	0.0	shore, boulder, rubble, cobble, gravel	
13B	22-Jun-04	9:18	695635	5322291	695635	5322292	0.460	0.852	0.392	2.4	rubble, cobble, gravel	
13C	22-Jun-04	9:19	695639	5322292	695638	5322293	0.890	0.852	-0.038	6.2	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13D	22-Jun-04	9:21	695644	5322298	695645	5322296	1.000	0.852	-0.148	12.7	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13E	22-Jun-04	9:24	695766	5322337	695764	5322342	0.960	0.852	-0.108	140.7	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13F	22-Jun-04	9:27	695889	5322387	695887	5322391	0.910	0.852	-0.058	273.5	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13G	22-Jun-04	9:29	695980	5322426	695980	5322427	0.880	0.852	-0.028	372.6	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13H	22-Jun-04	9:32	696078	5322466	696078	5322465	0.880	0.852	-0.028	477.9	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13I	22-Jun-04	9:35	696142	5322492	696142	5322491	0.860	0.852	-0.008	547.2	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
13J	22-Jun-04	9:35	696144	5322494	696145	5322492	0.490	0.852	0.362	550.4	sand, gravel	
13K	22-Jun-04	9:36	696149	5322493	696149	5322493	0.000	0.852	0.852	554.2	shore	
CROSS SECTION 14												
14A	22-Jun-04	9:50	695755	5322794	695755	5322794	0.000	0.743	0.743	0.0	shore, boulder, rubble, cobble, gravel	
14B	22-Jun-04	9:51	695760	5322796	695761	5322796	0.320	0.743	0.423	6.1	rubble, cobble, gravel	
14C	22-Jun-04	9:51	695766	5322799	695766	5322798	0.720	0.743	0.023	12.1	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14D	22-Jun-04	9:53	695778	5322809	695780	5322803	0.790	0.743	-0.047	26.8	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14E	22-Jun-04	9:55	695837	5322836	695841	5322827	0.650	0.743	0.093	92.5	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14F	22-Jun-04	9:55	695842	5322836	695845	5322828	0.340	0.743	0.403	96.5	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14G	22-Jun-04	9:57	695883	5322851	695886	5322844	0.500	0.743	0.243	140.6	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14H	22-Jun-04	9:58	695895	5322857	695898	5322849	0.700	0.743	0.043	153.9	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14I	22-Jun-04	9:59	695937	5322868	695939	5322865	1.050	0.743	-0.307	197.1	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14J	22-Jun-04	10:02	696017	5322899	696018	5322895	0.820	0.743	-0.077	282.1	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14K	22-Jun-04	10:02	696025	5322901	696026	5322898	0.610	0.743	0.133	290.6	sand, silt, some gravel	20 cm penetration, clam shells and some vegetation
14L	22-Jun-04	10:03	696029	5322900	696029	5322900	0.000	0.743	0.743	294.0	shore	

Sample Point	Sample Date	Sample Local Time (ADT)	Surveyed UTM Coordinate X (m)	Surveyed UTM Coordinate Y (m)	Projected UTM Coordinate X (m)	Projected UTM Coordinate Y (m)	Measured Water Depth at Time of Survey (m)	Geodetic Water Surface Elevation (m)	Geodetic Bottom Elevation (m)	Projected Distance from Left Bank (m)	Substrate Type	Comments
CROSS SECTION 15												
15A	29-Jun-04	16:24	695799	5323141	695799	5323141	0.000	0.229	0.229	0.0	shore	
15B	29-Jun-04	16:25	695802	5323141	695802	5323140	0.290	0.229	-0.061	2.8	sand, gravel	small channel
15C	29-Jun-04	16:26	695806	5323138	695806	5323140	0.000	0.229	0.229	6.7	sand, gravel	edge of sandbar
15D	29-Jun-04	16:27	695886	5323126	695887	5323132	0.000	0.229	0.229	88.3	sand, gravel	edge of sandbar
15E	29-Jun-04	16:30	695889	5323128	695890	5323132	0.130	0.229	0.099	90.9	sand, gravel	
15F	29-Jun-04	16:31	695896	5323128	695896	5323132	0.050	0.229	0.179	97.3	sand, gravel	
15G	29-Jun-04	16:31	695904	5323128	695904	5323131	0.130	0.229	0.099	105.7	sand, gravel	
15H	29-Jun-04	16:32	695908	5323128	695908	5323130	0.390	0.229	-0.161	109.7	sand, gravel	
15I	29-Jun-04	16:35	695917	5323136	695916	5323130	0.650	0.229	-0.421	117.3	sand, gravel	
15J	29-Jun-04	16:36	695938	5323125	695938	5323128	0.750	0.229	-0.521	139.6	sand, gravel	
15K	29-Jun-04	16:36	695940	5323126	695940	5323127	1.100	0.229	-0.871	141.7	sand, gravel	
15L	29-Jun-04	16:38	695945	5323126	695945	5323127	0.870	0.229	-0.641	146.6	sand, gravel	
15M	29-Jun-04	16:38	695946	5323126	695946	5323127	0.300	0.229	-0.071	147.4	sand, gravel, boulder, cobble	
15N	29-Jun-04	16:39	695948	5323127	695948	5323127	0.000	0.229	0.229	150.1	shore, boulder	
CROSS SECTION 16												
16A	29-Jun-04	17:42	695867	5323219	695867	5323219	0.000	-0.064	-0.064	0.0	shore, sand, boulder	
16B	29-Jun-04	17:45	695868	5323221	695867	5323219	0.240	-0.064	-0.304	0.8	sand, gravel	clam and mussel shells
16C	29-Jun-04	17:48	695880	5323211	695878	5323209	0.170	-0.064	-0.234	14.7	sand, gravel	clam and mussel shells
16D	29-Jun-04	17:50	695888	5323199	695888	5323200	0.730	-0.064	-0.794	28.5	sand, gravel	clam and mussel shells
16E	29-Jun-04	17:52	695894	5323199	695892	5323196	1.620	-0.064	-1.684	33.5	sand, gravel	clam and mussel shells
16F	29-Jun-04	17:53	695896	5323192	695896	5323192	1.310	-0.064	-1.374	39.2	sand, gravel	clam and mussel shells
16G	29-Jun-04	17:55	695901	5323195	695897	5323191	0.810	-0.064	-0.874	40.7	sand, gravel	clam and mussel shells
16H	29-Jun-04	17:56	695903	5323178	695907	5323183	0.640	-0.064	-0.704	53.8	silt, sand	
16I	29-Jun-04	17:59	695911	5323178	695912	5323178	0.170	-0.064	-0.234	59.9	silt, sand	
16J	29-Jun-04	18:00	695914	5323176	695914	5323176	0.030	-0.064	-0.094	62.9	silt, sand	
16K	29-Jun-04	18:01	695916	5323174	695916	5323174	0.000	-0.064	-0.064	65.9	shore, silt, sand	
CROSS SECTION 17												
17A	29-Jun-04	16:54	695904	5323295	695904	5323295	0.000	-0.151	-0.151	0.0	shore, sand, gravel	clam and mussl shells, lots of vegetation
17B	29-Jun-04	16:55	695905	5323289	695907	5323291	0.270	-0.151	-0.421	4.7	sand, gravel	clam and mussl shells, lots of vegetation
17C	29-Jun-04	16:55	695905	5323288	695908	5323290	0.750	-0.151	-0.901	6.4	sand, gravel	clam and mussl shells, lots of vegetation
17D	29-Jun-04	16:56	695909	5323285	695910	5323286	0.570	-0.151	-0.721	10.4	sand, gravel	clam and mussl shells, lots of vegetation
17E	29-Jun-04	16:57	695912	5323281	695913	5323282	0.790	-0.151	-0.941	15.4	sand, gravel	clam and mussl shells, lots of vegetation
17F	29-Jun-04	16:58	695916	5323278	695917	5323278	1.000	-0.151	-1.151	20.6	sand, gravel	clam and mussl shells, lots of vegetation
17G	29-Jun-04	16:59	695919	5323276	695918	5323276	1.140	-0.151	-1.291	23.7	sand, gravel	clam and mussl shells, lots of vegetation
17H	29-Jun-04	17:00	695921	5323274	695920	5323274	0.860	-0.151	-1.011	26.0	sand, gravel	clam and mussl shells, lots of vegetation
17I	29-Jun-04	17:02	695923	5323274	695921	5323272	0.400	-0.151	-0.551	27.6	sand, gravel	clam and mussl shells, lots of vegetation
17J	29-Jun-04	17:02	695922	5323271	695922	5323271	0.210	-0.151	-0.361	29.7	sand, gravel	clam and mussl shells, lots of vegetation
17K	29-Jun-04	17:03	695923	5323270	695923	5323270	0.000	-0.151	-0.151	31.1	shore, sand, gravel	clam and mussl shells, lots of vegetation

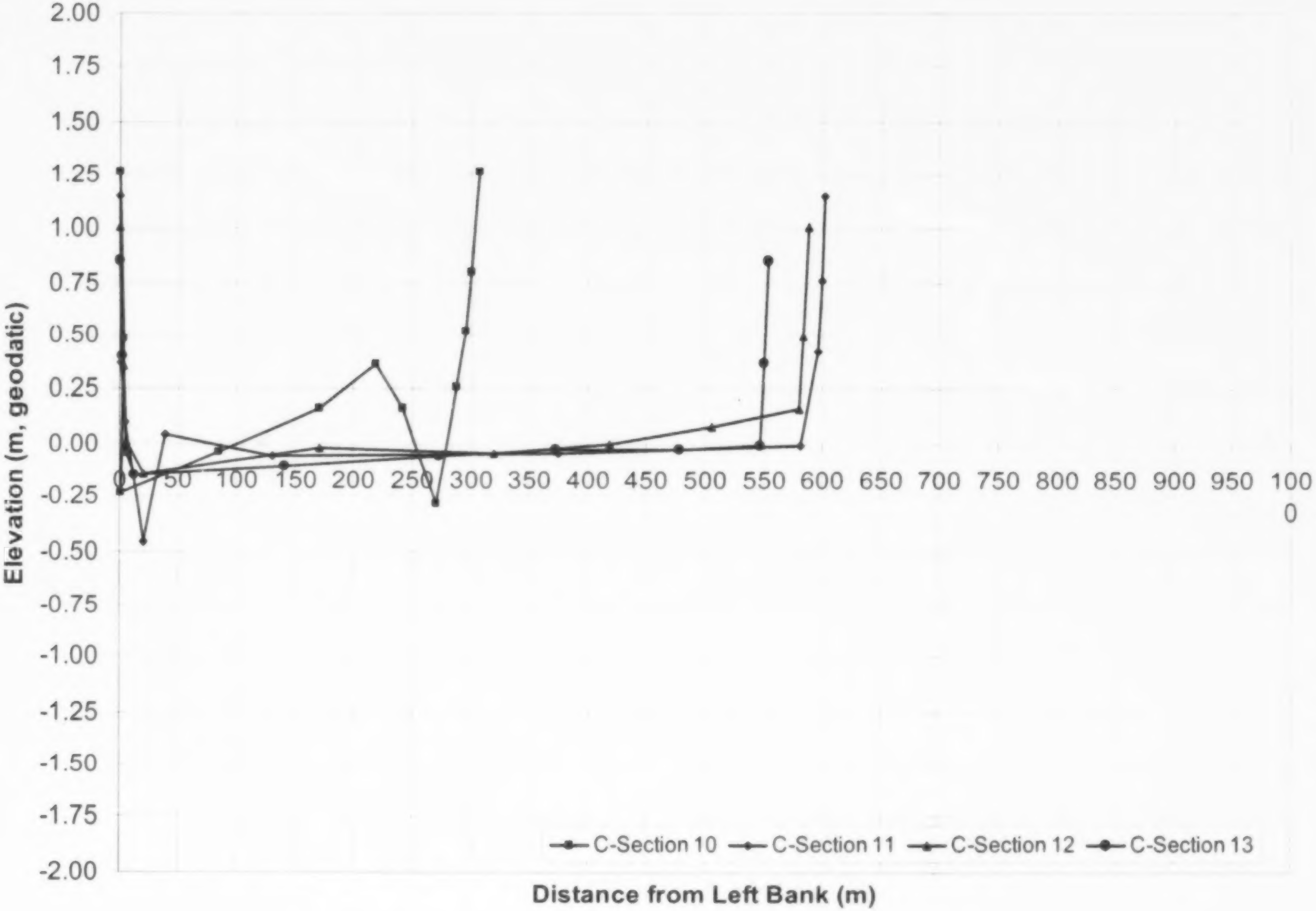
Jacques Whitford

Cross Sections



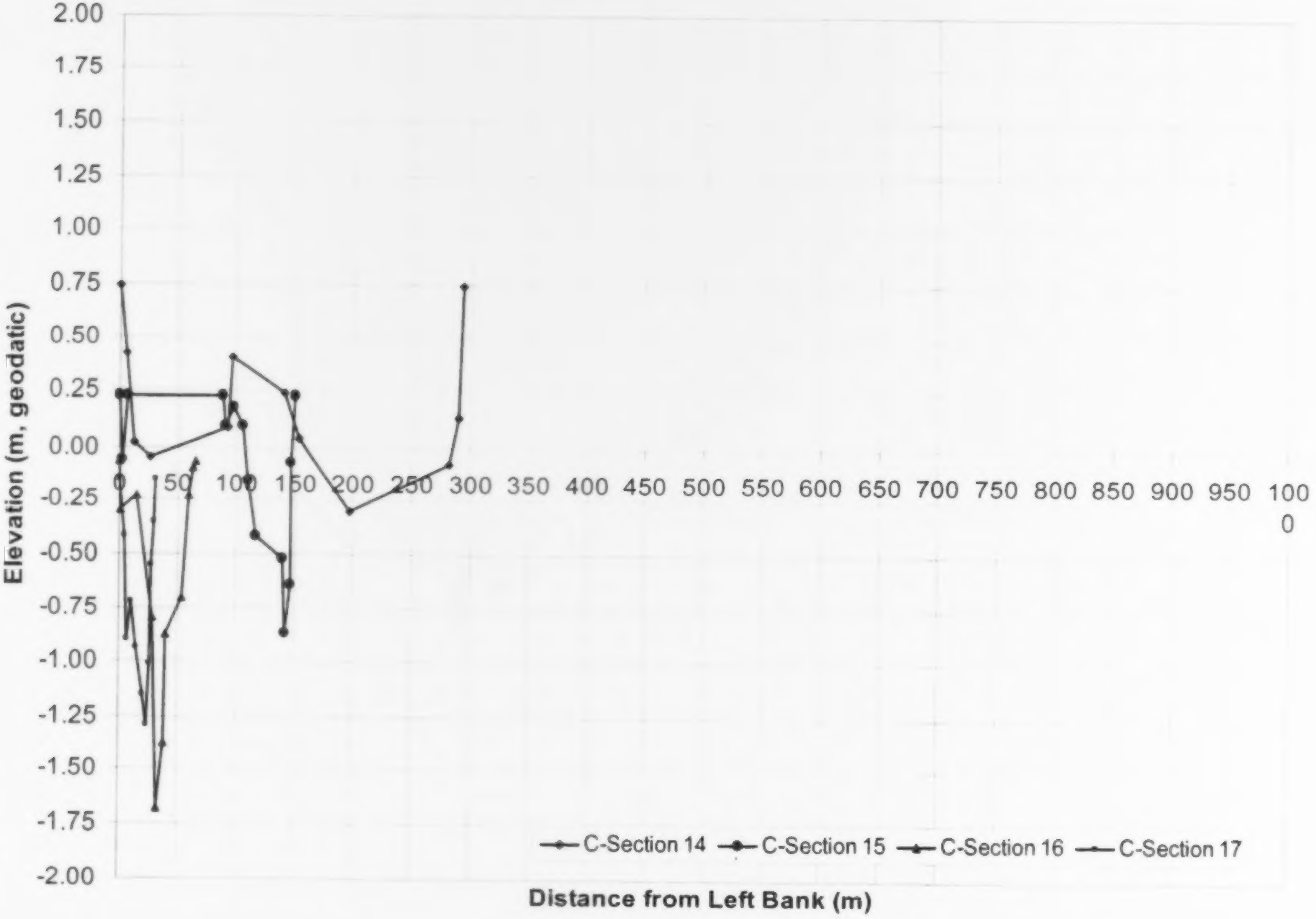

Cross Sections
Elevation (m, geodatic)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
-1.25
-1.50
-1.75
-2.00
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
Distance from Left Bank (m)
C-Section #6
C-Section #6B
C-Section#7
C-Section#8
C-Section #9

Cross Sections



Jacques Whitford

Cross Sections



SEDIMENT CORE RECORD

C1

CLIENT **NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES**
LOCATION **EEL RIVER IMPOUNDMENT**
DATES: **2004-06-28**
WATER LEVEL **N/A**
PROJECT No. **15830**
CORE No. **C1**
DATUM **GEODETIC**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	-0.19						
0		Organic Silty SAND			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
					BS	7	Used for composite sample
	-0.39				BS	8	Archived
		End of core @ 0.2 m					
1							

Jacques Whitford

SEDIMENT CORE RECORD

C2

CLIENT NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES
LOCATION EEL RIVER IMPOUNDMENT
DATES: 2004-06-28 WATER LEVEL N/A
PROJECT No. 15830
CORE No. C2
DATUM GEODETIC

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	0.48						
0		PEAT with silt			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
					BS	7	Used for composite sample
					BS	8	Archived
	0.28	Sandy SILT with some organics			BS	9	Used for composite sample
					BS	10	Archived
					BS	11	Used for composite sample
					BS	12	Archived
					BS	13	Used for composite sample
					BS	14	Archived
					BS	15	Used for composite sample
					BS	16	Archived
					BS	17	Used for composite sample
					BS	18	Archived
					BS	19	Used for composite sample
					BS	20	Archived
					BS	21	Used for composite sample
	-0.03	End of core @ 0.51 m					
1							

Jacques Whitford

SEDIMENT CORE RECORD

C3

CLIENT NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES
LOCATION EEL RIVER IMPOUNDMENT
DATES 2004-06-28
WATER LEVEL N/A
PROJECT No. 15830
CORE No. C3
DATUM GEODETIC

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
0	0.05	PEAT with silt			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
					BS	7	Used for composite sample
					BS	8	Archived
	-0.15	Sandy SILT with some organics			BS	9	Used for composite sample
					BS	10	Archived
					BS	11	Used for composite sample
					BS	12	Archived
					BS	13	Used for composite sample
					BS	14	Archived
					BS	15	Used for composite sample
					BS	16	Archived
					BS	17	Used for composite sample
					BS	18	Archived
					BS	19	Used for composite sample
					BS	20	Archived
	-0.45	End of core @ 0.5 m					
1							

Jacques Whitford

SEDIMENT CORE RECORD

C4

CLIENT	**NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES**	PROJECT No.	**15830**
LOCATION	**EEL RIVER IMPOUNDMENT**	CORE No.	**C4**
DATES:	**2004-06-28** WATER LEVEL **N/A**	DATUM	**GEODETIC**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	0.00						
0		Organic Sandy SILT			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
					BS	7	Used for composite sample
					BS	8	Archived
					BS	9	Used for composite sample
					BS	10	Archived
					BS	11	Used for composite sample
					BS	12	Archived
					BS	13	Used for composite sample
					BS	14	Archived
					BS	15	Used for composite sample
					BS	16	Archived
					BS	17	Used for composite sample
					BS	18	Archived
					BS	19	Used for composite sample
					BS	20	Archived
					BS	21	Used for composite sample
					BS	22	Archived
	-0.55	End of core @ 0.55 m					
1							

Jacques Whitford

SEDIMENT CORE RECORD

C5

CLIENT	NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES	PROJECT No.	15830
LOCATION	EEL RIVER IMPOUNDMENT	CORE No.	C5
DATES:	2004-06-28 WATER LEVEL N/A	DATUM	GEODETIC

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
0	-0.04	Organic Sandy SILT			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
					BS	7	Used for composite sample
					BS	8	Archived
					BS	9	Used for composite sample
					BS	10	Archived
					BS	11	Used for composite sample
					BS	12	Archived
	-0.35	End of core @ 0.31 m			BS	13	Used for composite sample
1							

Jacques Whitford

SEDIMENT CORE RECORD

C6

CLIENT **NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES**
PROJECT No **15830**
LOCATION **EEL RIVER GULLY**
CORE No **C6**
DATES: **2004-06-29**
WATER LEVEL **N/A**
DATUM **GEODETIC**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	-0.24						
0		SAND and GRAVEL			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
	-0.40	Silty SAND			BS	7	Used for composite sample
					BS	8	Archived
	-0.44	End of core @ 0.2 m					
1							

Jacques Whitford

SEDIMENT CORE RECORD

C7

CLIENT **NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES**
LOCATION **EEL BAY**
DATES **2004-06-29**
WATER LEVEL **N/A**
PROJECT No **15830**
CORE No **C7**
DATUM **GEODETIC**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	-1.78						
0		Silty SAND with black lenses			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
	-1.92				BS	6	Archived
		End of core @ 0.14 m					
1							

Jacques Whitford

SEDIMENT CORE RECORD

C8

CLIENT **NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES**
LOCATION **EEL BAY**
DATES: **2004-06-29** WATER LEVEL **N/A**

PROJECT No. **15830**
CORE No. **C8**
DATUM **GEODETIC**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	-1.60						
0		Silty SAND with black lenses			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
					BS	6	Archived
					BS	7	Used for composite sample
					BS	8	Archived
					BS	9	Used for composite sample
	-1.84				BS	10	Archived
		End of core @ 0.24 m					
1							

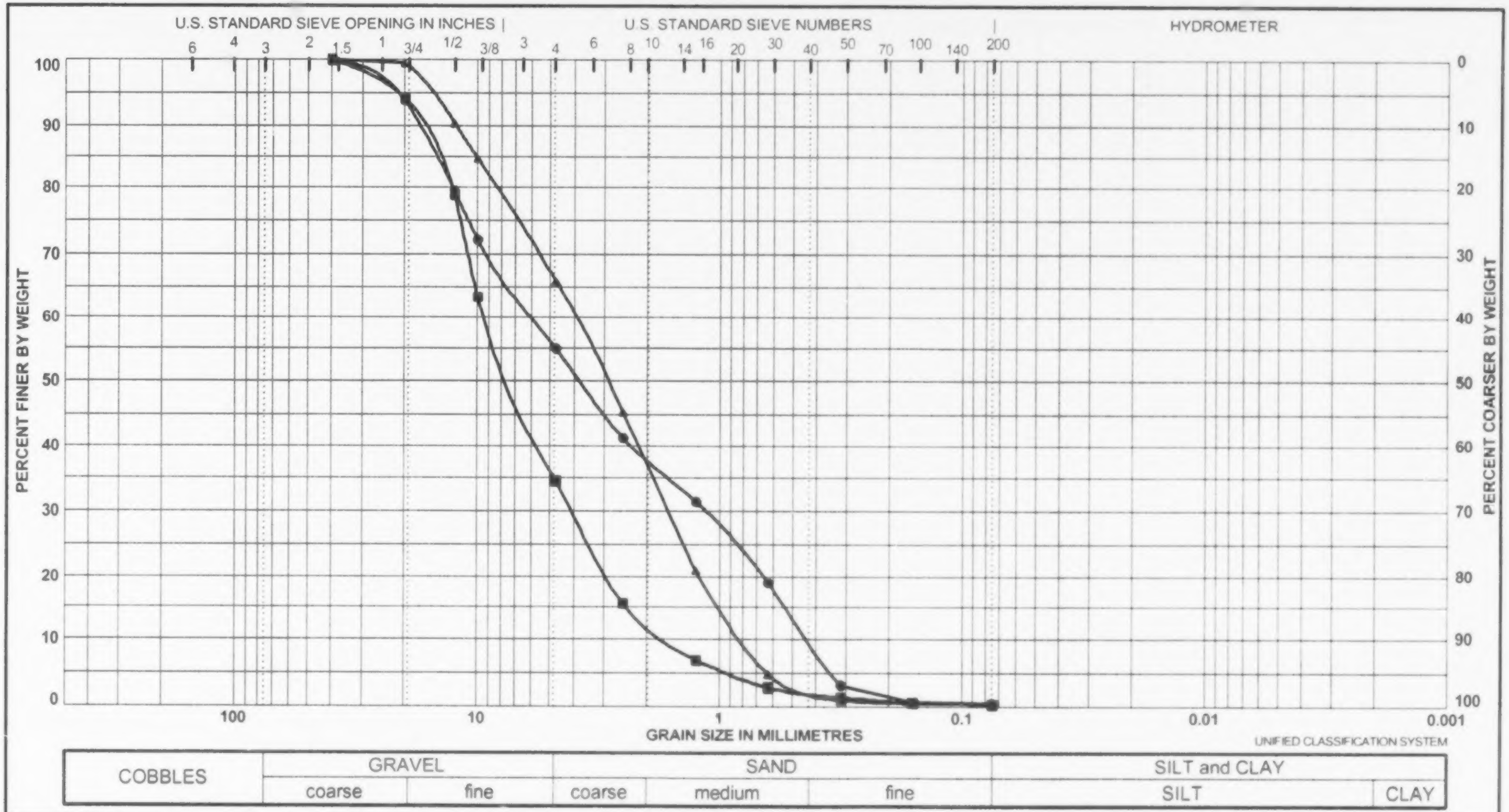
Jacques Whitford

SEDIMENT CORE RECORD

C9

CLIENT **NEW BRUNSWICK DEPARTMENT OF SUPPLY AND SERVICES**
LOCATION **EEL BAY**
DATES **2004-06-29**
WATER LEVEL **N/A**
PROJECT No **15830**
CORE No **C9**
DATUM **GEODETIC**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	REMARKS
	-0.74						
0		Silty SAND with some seashells			BS	1	Used for composite sample
					BS	2	Archived
					BS	3	Used for composite sample
					BS	4	Archived
					BS	5	Used for composite sample
	-0.89				BS	6	Archived
		Silty SAND with gravel			BS	7	Used for composite sample
	-0.95				BS	8	Archived
		End of core @ 0.21 m			BS	9	Used for composite sample
1							



Source	Sample	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● 2004 06 30	1	S1	7.5				45.0	54.5	0.5	
■ 2004 06 30	2	S2	7.5				65.5	34.2	0.3	
▲ 2004 06 30	3	S3	4.9				34.0	65.6	0.4	

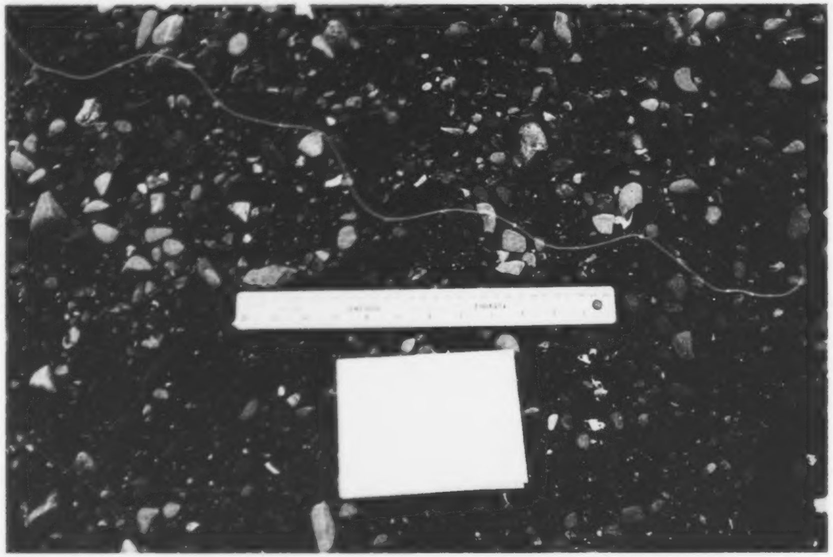
Jacques Whitford

Project: EEL RIVER DAM EIA
Job No.: 15830
Date: JANUARY 2005

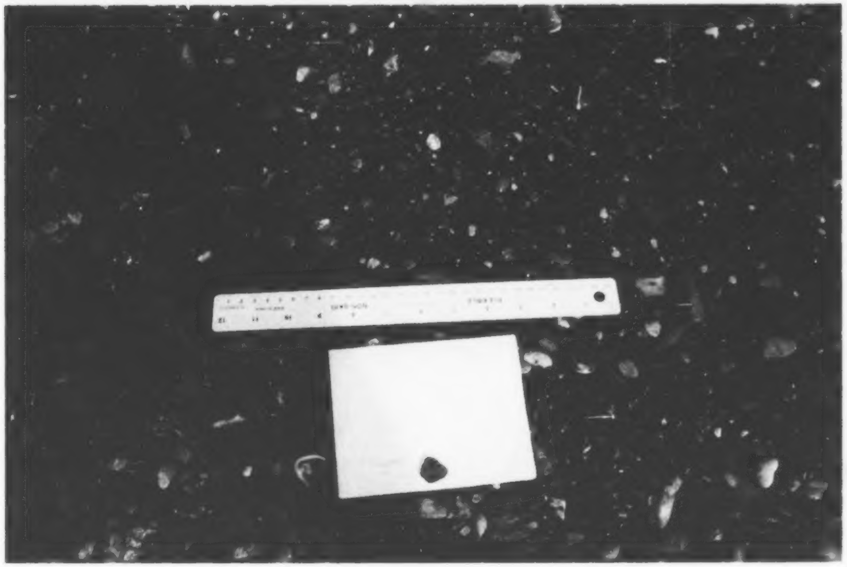
Location: EEL RIVER ESTUARY, NB
Notes:

GRADATION CURVES

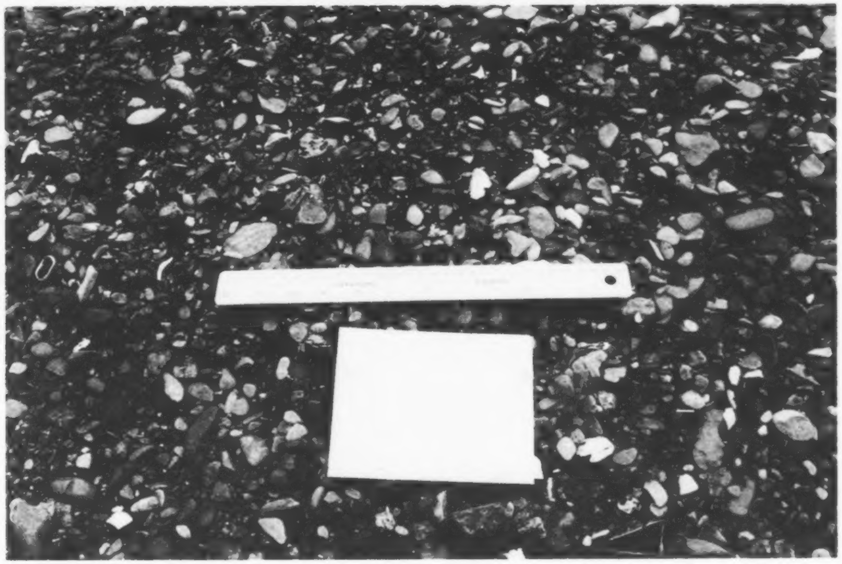
EEL RIVER SURFICIAL SEDIMENT SAMPLES FROM ESTUARY CHANNEL (TIDAL INLET). Refer to Figure 3.4.11 for location of samples.



Sediment sample S1 (coordinates X=695930.1824 Y=5323275.8500) was collected on June 30, 2004 at 9:25am. The sample consisted of sand and rounded gravel and was collected 10 cm above the water line on the falling tide. The largest stone on the surface at the sampling area was 4.5 cm long which calculated to a sample volume of 18 cm³.



Sediment sample S2 (coordinates X=695904.4416 Y=5323291.0870) was collected on June 30, 2004 at 9:45am. The sample consisted of sand and rounded gravel and was collected 10cm above the water line on the falling tide. The largest stone on the surface at the sampling area was 4cm long which calculated to a sample volume of $16cm^3$. While sampling, it was noticed that there was a higher concentration of sand in the top 3cm of the sample area with higher concentrations of gravel below.



Sediment sample S3 (coordinates X=695812.3112 Y=5323116.6430) was collected on June 30, 2004 at 10:05am. The sample consisted of sand and rounded gravel and was collected on an island in the gully 20cm above the water line on the falling tide. The largest stone on the surface at the sampling area was 4.5cm long which calculated to a sample volume of 18cm³. There was some rock and rubble on the surface in the area but it was not representative of the substrate.

www.jacqueswhitford.com

Jacques
Whitford